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EXTRACELLULAR FERRICYANIDE REDUCTION IN AEROPONICALLY AND HYDROPONICALLY GROWN CUCUMBER ROOTS: EFFECT OF EXCISION

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Abstract

Exogenous ferricyanide reduction by the roots of cumumber (*Cucumis sativus* L.) seedlings grown aeroponically (AP), in glass pots on moistened filter paper and hydroponically (HP), in a culture solution was measured for 7 days after germination.

In case of short term incubation (2 h) there was generally no difference in transplasmalemma electron transport of AP and HP roost, even if they had been excised, but after long term incubation (6 h) AP roots exhibited higher capacity for ferricyanide reduction.

Soluble sugar content of roots under AP condition increased parallel with the ferric-reducing activity.

Assuming that in vivo, NADH and NADPH provided from the cytoplasm are the main substrates of the ferricyanide reductase reaction, in long term experiments, the reduction of ferricyanide at the root surface reflects the energy reserves of plant part in question. The difference in ferricyanide reduction of AP and HP roots in short term incubation coincided with the maximal difference in soluble sugar content.

Comparing the earlier results of K^+ uptake of AP and HP cucumber seedlings with the ferricyanide reduction of roots potassium uptake doesn't seem directly coupled to the ferric-reducing activity of roots.

Key words: cucumber seedling, aeroponic and hydroponic cultures, plasma membrane electron transfer

Abbreviations: AP, aeroponic; DCMU, 3-(3,4-dichlorophenyl)1,1-dimethylurea; HP, hydroponic; FeCN, $K_3Fe(CN)_6$

Introduction

The early concept, that redox reactions at the surface of plant roots were involved in the ion uptake, was developed by LUNDEGÅRDH (1955) into the hypothesis of anion respiration: redox processes of the plasmalemma ensure the driving force for anion uptake.

The experiments on the interdependence between redox processes of plasmalemma, light induced changes in membrane potential and ion uptake was revived by NOVAK and IVANKINA (1977; 1978). They found correspondence between time-courses of membrane potential, K^+ transport and ferricyanide reductase activity of the plasmalemma of *Elodea* cells which had analogous responses to light turning on and off (NOVAK et al., 1988).

Redox reactions at the plasmalemma of higher plants can be investigated by two main method of approach. In vivo, the electrons of a cytoplasmic donor — which proved to be NAD(P)H in the known cases (SIMONS et al. 1984a; QIU et al.,

1985) — reduce an external, impermeable oxidant, such as $K_3Fe(CN)_6$ (NOVAK and IVANKINA, 1978), hexachloroiridate IV (LÜTHEN and BÖTTGER, 1988) or O_2 (KOMOR et al., 1987).

Redox components and reactions, e.g. NAD(P)H-ferricyanide oxidoreductase (BARR et al., 1986), are well characterised in highly purified plasmalemma preparations, too (ASKERLUND et al, 1988; LIN, 1982; MØLLER and BÉRCZI, 1985).

Two main types of plasmalemma redox activities have been characterized recently. The first, — so-called „Turbo reductase" — has been identified in the roots of Fe-deficient plants (except: Gramineae), and exhibits an inducible character (BIENFAIT, 1985). The second, the „Standard reductase" which doesn't depend on Fe-status of plants, is a constitutive one at the plasmalemma of all plants investigated (QIU et al., 1985; BIENFAIT, 1985).

Other possible physiological functions of plasmalemma electron transfer in plant cells have been excellently reviewed by DAHSE et al. (1989).

Earlier results at our department demonstrated striking differences in the growth and K^+ ($^{86}Rb^+$) uptake of wheat and cucumber plants grown under hydroponic (HP) or aeroponic (AP) conditions (ZSOLDOS et al., 1987). AP-grown seedlings exhibited a very low uptake rate of K^+, phosphate, sulphate and nitrate which seemed to be a passive process. This phenomenon developed about three days after soaking the seeds.

The possibility of the involvement of plasmalemma redox systems in ion uptake derived from the evidence for the electrogenicity of the redox pumps (SIJMONS et al., 1984b). Adding external NADH to the incubation medium of maize protoplasts LIN (1984) found an increase in membrane potential, with simultaneous increase of K^+ influx.

In the present paper we investigatmd the in vivo FeCN reductase activity in HP and AP cucumber roots in order to compare the tendencies with earlier findings in K^+ uptake. Furthermore, experiments were carried out to estimate the effect of energy reserves of roots on FeCN reduction in connection with root excision.

Materials and Methods

Plant cultures: Seeds of cucumber (*Cucumis sativus* L. cv. Budai csemege) were surface-sterilised for 20 min in commercial bleach) 1 part 5% NaOCl to 3 parts H_2O). After rinsing with distilled water they were germinated for 24 hours in the dark at 25 °C on filter paper moistened with nutrient solution (TARI and SZABÓ, 1990), in 500 ml glass pots. From the second day the seedlings were grown under controlled conditions (25/20 °C day/night temperature, 12 h light period, 70% relative humidity) either in pots, on filter paper (aeroponic conditions) or in hydroponic cultures.

AP seedlings were sprayed every day with nutrient solution. One AP plant received one-thirtieth part of the total nutrient quantity for a HP plant. Plants in HP were floated on hydrophobic plastic discs.

Redox assay: Generally 10 excised or intact roots of cucumber seedlings were rinsed in $5 \cdot 10^{-4}$ M $CaCl_2$ solution and placed into 100 ml beakers containing the assay solution in an appropriate volume. The fresh mass: volume ratio was kept constant (0,01 g/ml) every day. The incubation medium contained 1 mM 2-amino-2-(hydroximethyl)1,3-propanediol-2-(N-morpholino)ethanesulphonic acid (TRIS-MES), pH = 6,5, 1 mM $CaCl_2$ and 1 mM $K_3Fe(CN)_6$. The beakers were shaken and tissues were incubated

in the dark during the 6 hours of experiments. The optimum parameters of FeCN reduction were determined by 3-day-old AP plants. The rate of $K_3Fe(CN)_6$ reduction was measured as a decrease in A_{420} after correction for A_{500} at 23 °C. We couldn't find any difference between FeCN reduction performed under nonsterile or aseptic conditions.

Analysis of soluble sugars: 0,3 g of homogenized plant material was extracted with 80% ethanol. Extracts were centrifuged at 12,000 g for 15 min and resulting pellet reextacted in 80% ethanol. The combined supernatants were evaporated to dryness and resuspended in 2 ml of distilled water. Soluble sugars of roots were estimated by the phenol-sulfuric acid method (DUBOIS et al., 1956) and expressed as glucose equivalent. Reducing sugars were measured in an aliquot by the method of NELSON(1944).

Oxygen uptake of roots: According to VAN DER WERF et al. (1988) oxygen consumption of one root cut into 1 cm long segments was measured in 5.10^{-4} M $CaCl_2$ solution with a Clark type oxygen electrode (Hansatech) at 23 °C in the dark for 15—30 min (fresh mass: volume ratio was 20 mg/ml), and repeated 6 times in two independent experiments.

Statistics: The results were subjected to statistical evaluations with F- and Student-t tests. Numerical data of FeCN reduction are given as means ± SE, n = 5.

Results and Discussion

FeCN reduction at the root surface can be measured on intact plants (BÖTTGER and HILGENDORF, 1988; VAN BAUSICHEM, 1988; CSEH, 1988), excised roots (IVANKINA and NOVAK, 1988) and root segments (SIJMONS et al., 1984a; QIU et al., 1985). In these later cases the excision, as a wounding and as the cessation of sugar and hormone transport from the shoots, can directly and indirectly influence the transmembrane electron transport, e.g. effect of auxins on plasmalemma redox system are well documented (BRIGHTMAN, 1988; BÖTTGER and HILGENDORF, 1988).

The optimum conditions for FeCN reduction of cucumber roots were determined in preliminary experiments (Fig. 1). (Optimum pH and root number see in Materials and Methods). Fe-efficiency reactions in Fe-free nutrient solution, among

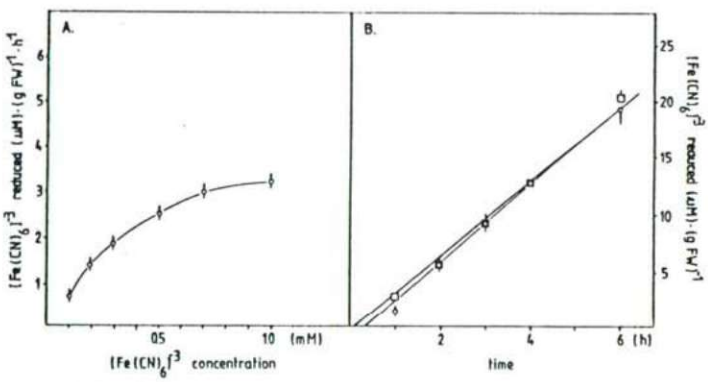

Fig. 1. Ferricyanide reduction by roots of aeroponically grown cucumber seedlings on the third day of germination. A: Effect of ferricyanide concentration on ferricyanide reductase activity of intact plants. Incubation period was 6 hours. B: Time-course of ferricyanide reduction in intact (○) and excised (□) AP cucumber roots. Incubation solution contained 1 mM Tris-Mes (pH = 6,5), 1 mM $CaCl_2$ and in B. 1 mM $K_3FeCN_{(6)}$. Data are expressed as a mean ± SE (n = 5)

others „Turbo" reductase activity in cucumber roots developed on the 7th day under HP. (Data not shown). So we suppose that the reduction of ferricyanide at least at early stages of seedling growth reflects the standard reductase activity.

FeCN reduction of AP and HP cucumber roots was determined for the first 7 days of the development (Fig. 2).

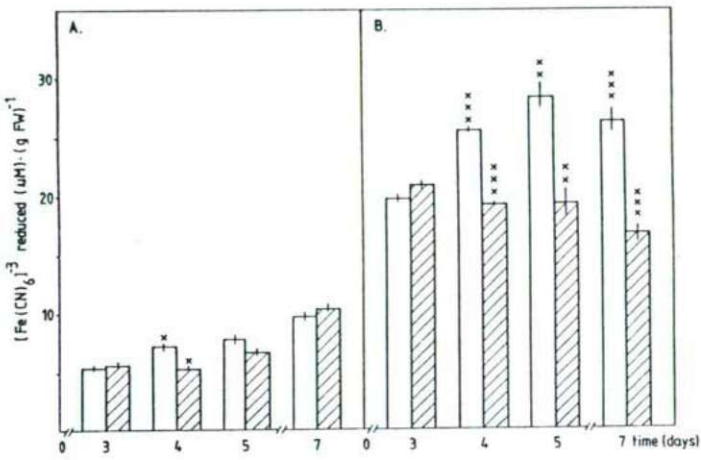

Fig. 2. Time-course of ferricyanide reduction at the root surface of AP (empty columns) and HP (hatched columns) cucumber plants. Incubation periods were 2 (A) and 6 (B) hours. Data are expressed as a mean ± SE (n = 5). Significant at P = 0,05 (single asterics), P = 0,01 (double asterics) and P = 0,001 level (triple asterics).

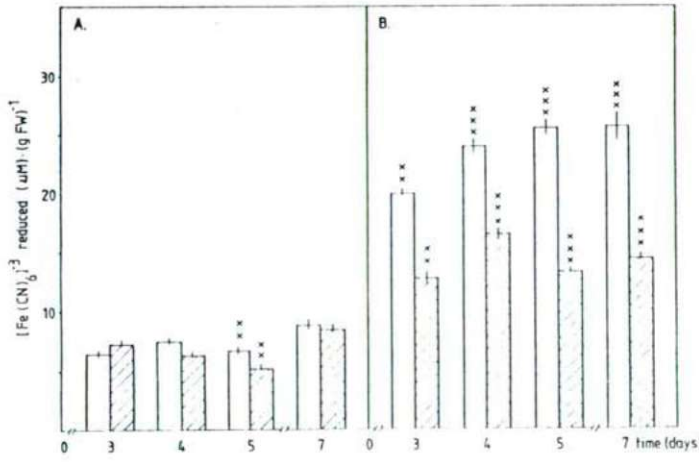

Fig. 3. Time-course of ferricyanide reduction at the root surface of excised AP (empty columns) and HP (hatched columns) cucumber roots. Incubation periods were 2 (A) and 6 (B) hours. Otherwise as in Fig. 2.

The effect of root excision has also been analysed (Fig. 3). In short term experiments (2 h), except one case, there was no significant difference between AP and HP roots, but in longer incubation (6 hours) AP tissues exhibited higher capacity for FeCN reduction both in intact and in excised roots. Excision did not affect the FeCN reduction of AP roots but resulted in lower values in HP ones.

In photosynthetic tissues such as Elodea cells transplasmalemma electron transport was inhibited by DCMU, an inhibitor of noncyclic electron transport in chloroplast in the light, and at the same time glucose, a substrate for respiration, resulted in an increase of FeCN reductase activity in the dark (NOVAK et al., 1988).

Carbohydrate content of roots can be modulated by several external or internal factors. Light-induced changes in abscisic acid level (WILKINS et al., 1974; DÜRING et ALLEWELDT, 1960) or in cell wall-bound invertase activity of wheat roots (KRISHNAN et al., 1985) have been known to increase the sugar content of roots.

AP roots in Petri dishes or in glass pots on filter paper are exposed to several conditions which affect the substrate pool for respiration or respiration itself: they are growing in the light, in a relatively closed room where the concentrations of CO_2 and O_2 and water potential differ from hydroponics.

The effect of AP conditions on soluble and reducing sugar content and oxygen consumption of roots are summerized in Figs. 4 and 5.

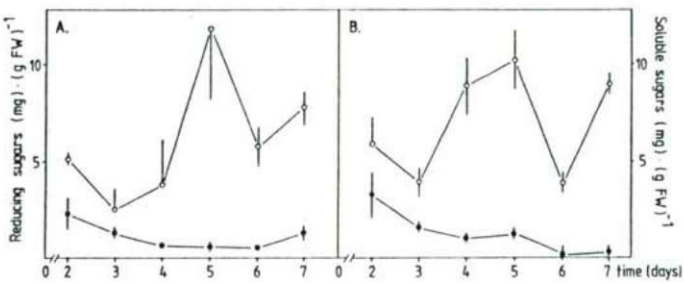

Fig. 4. Changes in the level of reducing (A) and soluble (B) sugar content of AP (○) and HP (●) cucumber roots. Vertical bars denote SD.

Changes in soluble carbohydrate level of the roots of intact plants correspond well with the FeCN reductase activity in long term incubation, but a peak in O_2 consumption of AP roots followes the increase in the substrate level for respiration. This suggests that the conventional respiratory control (ADP availability for mitochondrial electron transport chain, control of glycolysis and Krebs tricarboxylic acid cycle by ATP) took place before the increase in O_2 consumption.

On the contrary, the oxygen consumption of excised root segments depended on the endogenous soluble sugar content of the tissue during 20 hours incubation period of maize root segments (SAGLIO and PRADET, 1980). Exogenous glucose could restore the respiratory O_2 consumption to the initial value, indicating a control of respiration by the substrate when the tissue was in shortage of energy reserves.

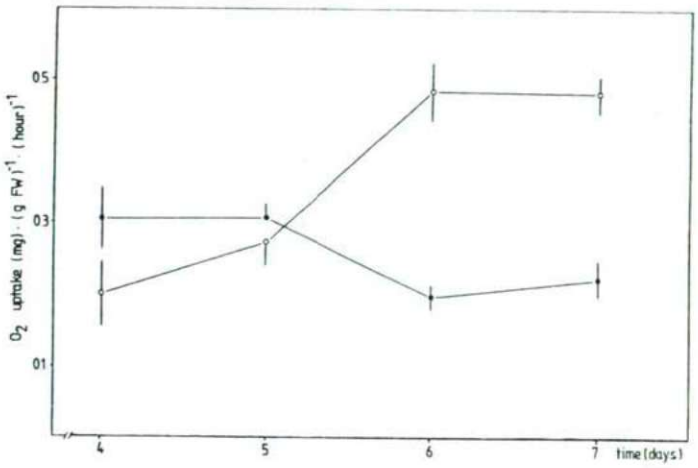

Fig. 5. Changes in total O_2 uptake of AP (○) and HP (●) cucumber roots. Vertical bars represent ± SD (n = 6).

Root segments with high soluble carbohydrate reserves can maintain higher respiration rate and reduced coenzyme level which result in higher capacity for the reduction of exogenous FeCN in long term experiments.

The data presented here demonstrate that there is no difference in FeCN reducing activity of intact and excised roots of AP and HP plants if the incubation period is short enough. Results of longer incubation and of excision, which desreased FeCN reduction of HP but did not that of AP roots, reflect the differences in carbohydrate reserves of roots.

In short term incubations we found differences only at the peak of soluble sugar content in AP roots.

These data support the view of ERDEI et al. (1989) who suggest that K^+ uptake need not be directly coupled to the redox activity at the plasmalemma of the Fe-deficient and sufficient sunflower and wheat roots. The low K^+ uptake rate in AP cucumber roots can be explained by the increase in osmotically active sugars which can substitute K^+ under osmotic stress (CUTLER et al., 1977).

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HORMONAL REGULATION OF ROOT FORMATION IN PACLOBUTRAZOL TREATED BEAN PLANTS

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Abstract

Besides retarding expansion growth paclobutrazol stimulates the root forming process both in intact plants and stem cuttings.

The promoting effect on the rooting process in primary leaves of treated plants was not observable, the formation of root primordia was definitely inhibited in petioles. This inhibition can be overcome by IBA, ABA and ethylene-generator treatment, and all the three cases the initiation of root primordia can be prevented by STS pretreatment.

Results are discussed in connection with the endogenous IAA content and ethylene production of bean plants.

Key words: abscisic acid, bean, IAA content, IBA, ethylene, paclobutrazol, *Phaseolus vulgaris*. rhisogenesis, STS

Introduction

Stimulation of root formation is a known side effect of plant growth retardants.

The triazole derivative paclobutrazol (PP333) is also characterized by such effect both in intact plants and stem cuttings (STEFFENS et al., 1983; LENZ, 1984; STEFFENS and WANG, 1984; DAVIS et al., 1985; SEBANEK et al., 1991).

PP333 originally had been developed as fungicide, but today it is used as a potent growth retardant which is active in a wide range of plant species (LEVER, 1986)

The retarding effect of PP333 on shoot growth is generally explained by the inhibition of gibberellin-biosynthesis (DALZIEL and LAWRENCE, 1984; HEDDEN and GRAEBE, 1985; LEVER, 1986; GRAEBE, 1987). In connection with the rooting process its effect on the indole-3-acetic acid (IAA) metabolism should also be taken into consideration since it is generally well accepted fact that IAA has an important role in rooting process (TORREY , 1976; HARTMAN and KESTER, 1983).

Since the stem-thickening effect of retardants in the basal part of the stem is a characteristic ethylene effect as well, in the induction of rooting the production of ethylene may be also important.

In our present work we investigated the IAA content and its distribution, the ethylene production of the hypocotyls and primary leaves of beans treated with PP333 in connection with their rooting capatity.

Material and Methods

Seeds of *Phaseolus vulgaris L.* c. v. Juliska were soaked in a paclobutrazol (ICI, USA) solution containing 5 $mg \cdot l^{-1}$ of the active component in a thermostat at 25 °C. On the 3rd day they were sowed into garden mould. The plants were grown under controlled conditions (CONVIRON Cabinet model EF7, equipped with 4×50 W Sylvania incandescent lamps, at 25/20 °C day/night temperatures respectively, 16 h illumination with 21 Wm^{-2} and 65% relative humidity). The IAA-content and ethylene production of the hypocotyls was measured in six-day-old plants, while that of the primary leaves in fourteen-day-old ones. The hypocotyls were divided into two parts of the same length, in the case of leaves the laminae and petioles were separate and the amount of IAA was determined separately in both parts.

Measurement of IAA-content: the IAA-contents of hypocotyls and that of primary leaves were determined after extraction with 80% cold methanol.

The extract was evaporated to dryness under reduced pressure, then it was purified and fractionated according to the method of KAMISAKA and LARSEN (1977). The amount of IAA present in the final acidic ether fraction was measured by the indolo-α-pyrone fluorescence method (KNEGT and BRUINSMA, 1973; HEMBERG and TILLBERG, 1980) with a PERKIN-ELMER spectrofluorimeter.

Losses of IAA during extraction and purification were estimated by adding a known amount of [2-^{14}C]-IAA (Amersham, U. K., 120 GBq/mol IAA^{-1}) as an internal standard.

Measurement of ethylene-production: ethylene was measured by a gas chromatograph fitted with a flame ionization detector and an alumina column. Plant parts were enclosed in 20—100 ml gas tight flaske and samples were withdrawn from the flask with a Hamilton gas-tight syringe and analysed isothermally after 6-h-incubation.

All experiments were repeated at least three times and measured 5 parallel samples.

In the experiments on root formation stem and primary leaf cuttings were immersed in fourth strength Hoagland nutrient solution supplemented with 1 ml of complex solution of micronutrients.

In order to promote rooting the primary leaves were evenly moistened with 1 μl of 1 mg/l indole-3-butyric acid (IBA, Reanal) and abscisic acid (ABA, Sigma) solution containing 0,05% TWEEN 80 as a detergent.

The ethylene treatment was carried out by „Rol-Fruct" an ethylene-generator, contaning 40% 2-chloroethyl-phosphonic acid (Chinoin Co., Budapest). 0,04 μg of agent was spread over the entire surface of one leaf.

0,1 mM silver thiosulfate (STS, O,1 mM $AgNO_3$ + 0,1 mM sodium thiosulfate) was applied to inhibit the effect of ethylene.

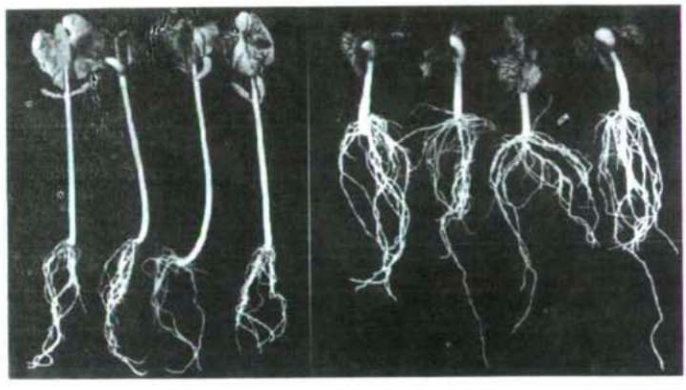

Fig. 1.: Effect of PP333 on the growth of six-day old *Phaseolus vulgaris* cv. Juliska seedlings. (Left: control, right: treated plants)

Results

The effect of PP333 treatment on growth of bean seedlings is presented in Fig. 1. and Table 1.

Besides retarding expansion of shoot growth, stimulation of stem-thickening, richer and longer roots are the main morphological differences between the treated and control plants.

From the point of view of the retarding effect on shoot elongation and the stimulating effect on root growth first of all the knowledge of the effect on IAA content is important.

The results are summarised in Table 2.

In the hypocotyls of PP333 treated plants the total IAA content is higher than that of the control, but the distribution ratio between the apical and basal part was changed comparing to the control. This new proportion is favourable only for rooting process but disadvantageous for elongation growth of the shoot.

Table 1. Effect of paclobutrazol on the growth of bean plants (Data of six-day old plants)

	hypocotyl				root		
	length mm	diameter of basal part mm	fresh weight g	dry weight mg	length of primary root mm	fresh weight g	dry weight mg
Control	108,8±11,2	3,1±0,2	1,052±0,290	55,5±5,1	110,21±11,50	0,464±0,029	41,46±5,05
Treated	37,9±12,1	5,2±0,3	0,534±0,190	33,7±5,9	194,40±14,30	1,027±0,040	56,88±7,16

Table 2. Effect of paclobutrazol on the IAA content and quantitative distribution between apical (A) and basal (B) parts of hypocotyls

	Control		Treated	
	A	B	A	B
ng IAA/hypocotyl part	1,8±0,5	2,4±0,4	2,2±0,6	4,9±0,6
ng IAA/fresh mass	2,7±0,2	3,6±0,5	3,7±0,5	7,2±0,6
distribution in % of the total quantity	42,85	57,15	30,98	69,02

Table 3. Effect of paclobutrazol on the ethylene production of the apical (A) and basal (B) parts of bean hypocotyls

	Control		Treated	
	A	B	A	B
ethylene nl/hyp. part/h	0,093±0,008	0,087±0,006	0,003±0,0001	0,0527±0,004
ethylene/g fresh mass/h	0,130±0,040	0,110±0,030	0,070±0,0100	0,1200±0,030
distribution of ethylene production between A and B parts of hypocotyls as % of total ethylene release	51,7	48,3	5,4	94,6

In the effect of PP333 on the ethylene production of hypocotyls (Table 3.) the effect on the total ethylene production is not so striking than the difference between the levels of ethylene formation in the apical and the basal parts.

In the primary leaves of PP333 treated plants an increase in rooting capacity was not observable, on the contrary the formation of root primordia were definitely inhibited in petioles (Fig. 2.). After PP333 treatment the distribution of IAA between petiole and blade was changed (Table 4.).

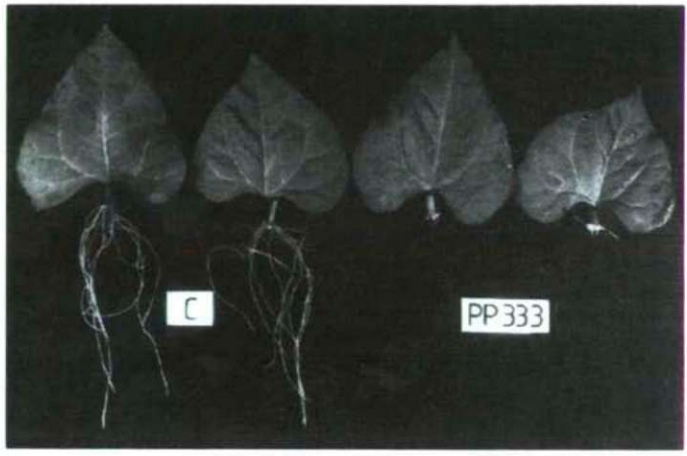

Fig. 2.: Adventitious root formation of detached primary leaves of PP333 treated bean plant

Table 4. Effect of paclobutrazol on IAA content and its distribution in blade and petioles of bean leaves

	Control		Treated	
	blade	petiole	blade	petiole
ng IAA/leaf part	3,5±0,6	3,2±0,5	7,8±0,6	3,1±0,6
ng IAA/g fresh mass	4,4±0,1	8,6±0,4	9,7±0,5	6,2±0,8
distribution in % of the total IAA quantity between blade and petiole	52,23	47,77	71,55	28,45

Table 5. Effect of paclobutrazol on the ethylene production of the blade and petiole of bean leaves

	Control		Treated	
	blade	petiole	blade	petiole
ethylene nl/plant part/h	0,790±0,07	0,0520±0,01	2,690±0,62	0,0310±0,01
ethylene nl/g fresh mass/h	1,780±0,67	0,5400±0,02	7,150±0,43	0,6900±0,02
distribution of ethylene production between blade and petiole as % of total ethylene release	93,8	6,2	98,9	1,1

The quantity of ethylene production is also changed in the blade and petiole; in the petioles of primary leaves of treated plants only a lower ethylene production can be measured (Table 5.).

The inhibiting effect of PP333 on rooting of primary leaves can be overcome by IBA (Fig. 3.), ABA (Fig. 4.) and ethylenegenerator (Fig. 5.) treatment, and in all three cases the inhibition can be restored by STS.

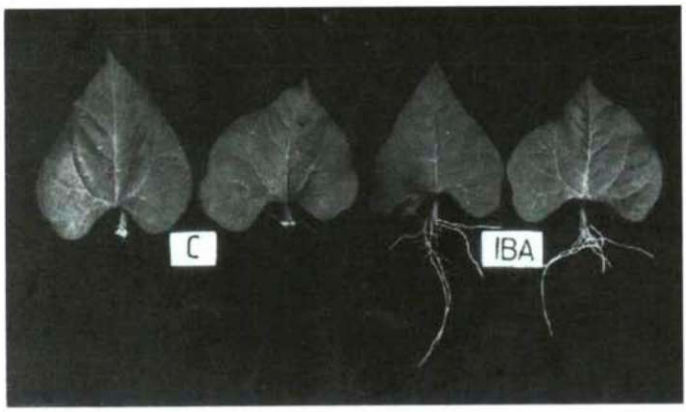

Fig. 3.: Effect of IBA on the adventitious root formation of detached primary leaves of bean plant pretreated with PP333.

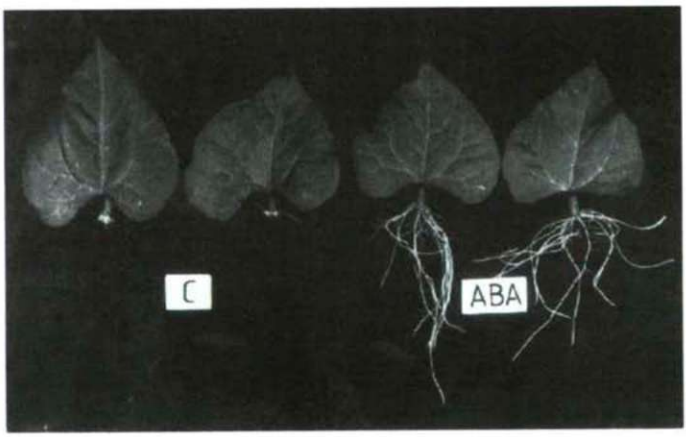

Fig. 4.: Effect of ABA treatment on the adventitious root formation of detached primary leaves of bean plant pretreated with PP333.

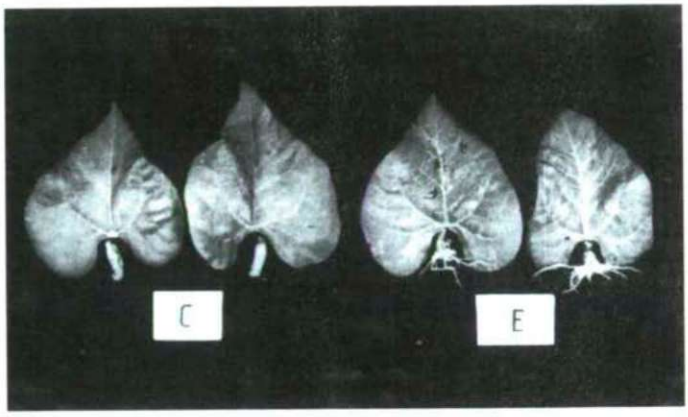

Fig. 5.: Effect of ethylene-generator (E) treatment on the adventitious root formation of detached primary leaves of bean plant pretreated with PP333.

Discussion

Hormonal regulation of root formation was studied in bean hypocotyls and primary leaves treated with PP333.

In the hypocotyls of treated plants positive correlation can be observed between the effect of rooting capacity and the change of IAA distribution.

The higher IAA content measurable in the basal part of hypocotyls is advantageous for the induction of rooting process. The change in the IAA content involves the change in the ethylene production as well because of the known effect of auxin on the ethylene production (SHINGO and IMASEKI, 1971; BURG, 1973; LAU and YUNG, 1974; MALLOCH and OSBORNE, 1976).

The ethylene production of hypocotyl parts correlates well with their IAA content. The higher ethylene production in basal hypocotyl parts is advantageous for the root initiation and this is the cause of the stem-thickening too, observable at the basal part of hypocotyls which comes into beeing by stimulation of lateral expansion of the cells (CAMP and WICKLIFF, 1981; PINFIELD et al., 1984).

The PP333 treated primary leaves contain higher IAA amount than that of the control. Inspite of this root initiation is inhibited. The reason of this phenomenon may be partly the changed IAA-distribution in the primary leaf between the blade and petiole, on the other hand the high cytokinin content because of the treatment with a triazole derivative (FLETCHER and ARNOLD, 1986; GROSSMANN et al., 1987; IZUMI et al. 1988) don't make possible the advantageous IAA/cytokinin ratio for rooting. In the originating of favourable ratio ethylene has an important role by decreasing the cytokinin level (VAN STADEN et al., 1987; BOLLMARK and ELIASSON, 1990), but the ethylene amounts produced by PP333 treated leaves are not sufficient to this.

According to our results ethylene is primely important in this system, because the hormones which are capable of increasing the ethylene production of leaf blade and petiole are effective in promoting the formation of adventitious roots.

Besides the ethylene-generator „Rol-Fruct", abscisic acid (ABA) is also suitable to increase the ethylene production because the higher ABA level brings about higher ethylene production (MAYAK and DILLEY, 1976; GOREN, 1979; LIEBERMANN et al., 1977; SAGEE et al., 1980; WRIGHT, 1980; RIOV et al., 1990). Otherwise PP333 treatment decreases the endogenous ABA level in the leaves (WANG et al., 1987; BUTA and SPAULDING, 1991).

The effectiveness of IBA in initiation of root primordia may be due to the induction of high ethylene production in the region of adventitious root formation (RIOV and YANG, 1989). Effect of IBA on decreasing of cytokinin level in petioles (BRIDGALL and VAN STADEN, 1985; BOLLMARK and ELIASSON, 1990) may be connected with the great ethylene production too.

On the bases of our results ethylene can play a key role in this system in the origination of IAA/cytokinin ratio advantageous for the root forming process. Our suggestions are supported by the effect of Ag^+, an inhibitor of ethylene action which can prevent the stimulation of root formation in petioles of all three applied hormones.

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ACTA BIOL. SZEGED. 37. PP. 19—23. (1991)

ANATOMICAL CONNECTION BETWEEN INTRACELLULAR AND EXTRACELLULAR SECRETION IN SPECIES OF EUPHORBIA GENUS

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Abstract

In our research we examined the histological structure of the nectary of six species of *Euphorbia* (*E. cyparissias* L., *E. seguieriana* NECKER., *E. lucida* W. et K., *E. virgata* W. et K., *E. angulata* JACQ., *E. burmannii* E. MEY) by LM. We found that the glandular tissue of the nectary which functions as an extracellular secretional system is thoroughly woven through by the latex system, the intracellular secretional system characteristic of *Euphorbia* species. The laticifers end on the boundary of the epidermis of the gland, the nectar-secreting surface, and the glandular tissue.

By the anatomical connection of the two secretional systems their functional connection becomes quite probable.

Key words: histology, nectary, plant secretion, recent *Euphorbia*.

Introduction

All species of *Euphorbia* genus have a latex system which weaves through the plant thoroughly, and this system has the function of intracellular secretion of the plant. This secretional system consists of non-articulated laticifers which are longitudinally expanded unicellular growths (ESAU, 1953). The latex system in *Euphorbia* originates from a few specialized cells in the cotylendonary node which subsequently develop into branching coenocytes (CUMMINGS, 1941). The portion of the system in the cortex of the hypocotyl, from which branches extend into the cotyledons, is largely independent of the laticiferous elements of the stem (CAMERON, 1936). In 1985 METCALFE wrote comprehensively about the latex secreting systems in members of *Euphorbiaceae.*

Nectaries of *Euphorbia* species that have the function of extracellular secretion, originate from hypsophylls. These nectaries can be found on the calyculus of the *Cyathium* inflorescence, which has five parts. There are usually four or five nectaries, or occassionaly eight within one inflorescence. By their position they are extra-floral (CASPARY, 1848; EWERT, 1932; BEUTLER, 1953), by shape they are automorph nectaries (DELPINO, 1886; SCHOENICHEN, 1922).

Nectary-types of *Euphorbiaceae* family were described by METCALFE and CHALK (1957); in *Euphorbia* genus the patelliform type occurs most often.

All examined species have crescent-shaped or elliptical varieties of nectary-type.

Materials and Methods

We examined the nectaries of five *Euphorbia* species that occur in Hungary (*Euphorbia cyparissias* L., *E. seguieriana* NECKER., *E. lucida* W. et K., *E. virgata* W. et K., *E. angulata* JACQ.) and a tropical succulent one (*E. burmannii* E. MEY).

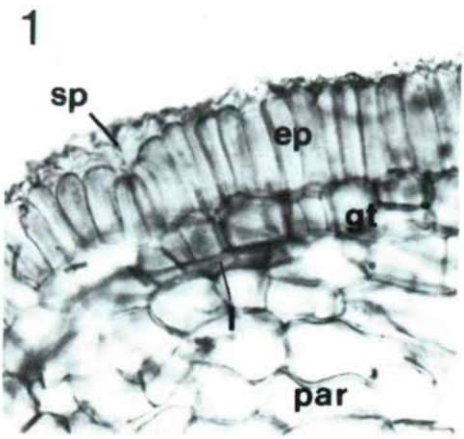
The glands collected from the plants were preserved in a 40 percent solution of ethylic alcohol until we used them. We embedded the glands in celloidin with the method described by KISSER (1920) and ROMEIS (1932) and modified by GULYÁS (1968). We made 20—30 μm thick cuttings of the embedded nectaries, then the celloidin was removed by ether, and, having cleaned the cuttings, we painted them with Erlich's haematoxilin and conserved them in Canada balsam. The slides were examined by NU-2 light microscope.

Results

In the longitudinal cuttings we studied the following tissue types:

The surface of the gland is built up of epidermis (ep); the major part of it works as nectar-secreting surface and is covered by cuticle (c). Its cells are perpendicularly expanded to the secreting surface, they look like columns put closely together. There are no stomas among them (Fig. 1). The nectar-secreting pores (sp) are built up of morphologically well-differentiated cells. They can be seen in the gland-epidermis of the species occuring in Hungary. In the gland-epidermis of the tropical species (Fig. 2) there are secreting papillas (sep). The epidermis of the tropical species mentioned above consists of slightly expanded, round cells in longitudinal cutting, divergently from the other species mentioned before. The blistered cuticle above the nectar-secreting papilla is shown on figure 2. The glandular tissue (gt) can be found under the epidermis. In the species that live in Hungary the glandular tissue consists of three or four layers of cells under the middle of the secreting surface, and two or three layers of cells in the marginal regions (Fig. 3). The glandular tissue of *E. burmannii* has seven or eight layers of cells. The cells of this tissue type are small, parenchyme and close to each other; there are no intercellular spaces between them (Fig. 4). In the glandular tissue laticifers (1) run towards the secreting surface, and they end on the epidermis of the gland and the glandular tissue (Fig. 4 and 6). They are parallel with the elements of the vascular tissue in a part of the calyculus connected to the gland, then they go on in disorder after the branching of the vascular tissue in the parenchyma weaving through the glandular tissue (Fig. 5 and 6). Under the secreting tissue the gland-parenchyma can be found (par). This is the storing part of the nectary. The parenchyma of the species occurring in Hungary is large in

Fig. 1—6.: Longitudinal cuttings of *Euphorbia* nectaries:
1. *E. cyparissias* 400 X; 2. *E. burmannii* 400 X;
3. *E. angulata* 100 X; 4. *E. burmannii* 400 X;
5. *E. seguieriana* 200 X; 6 *E. angulata* 480 X;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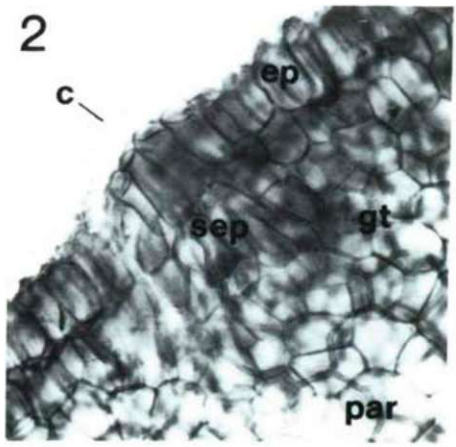
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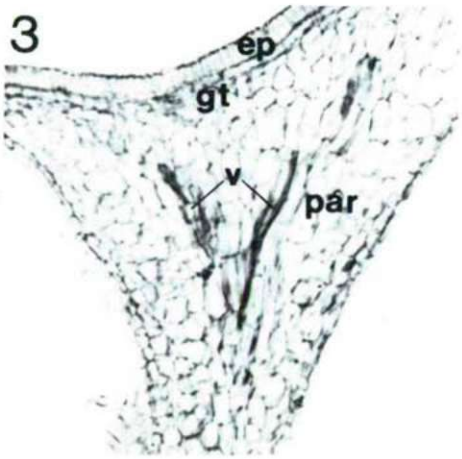
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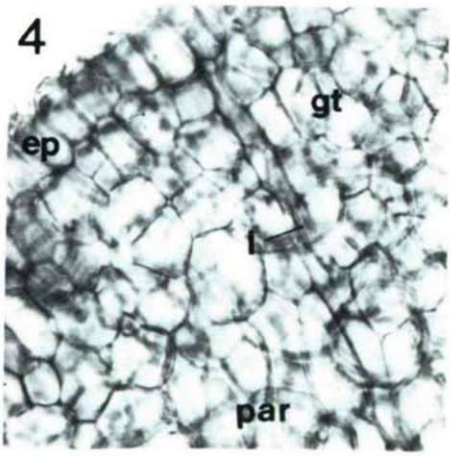
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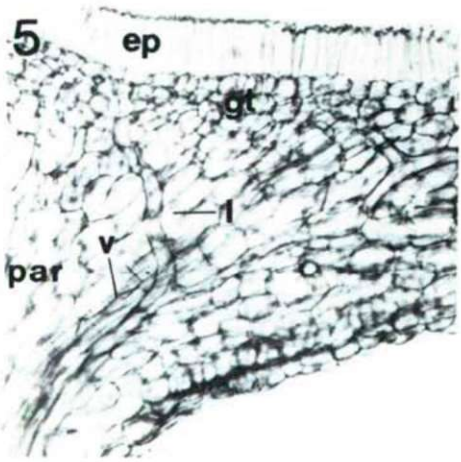
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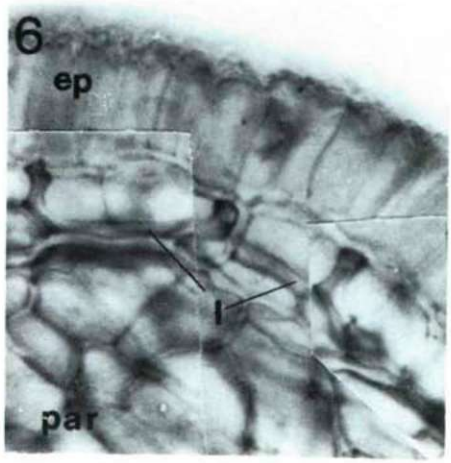
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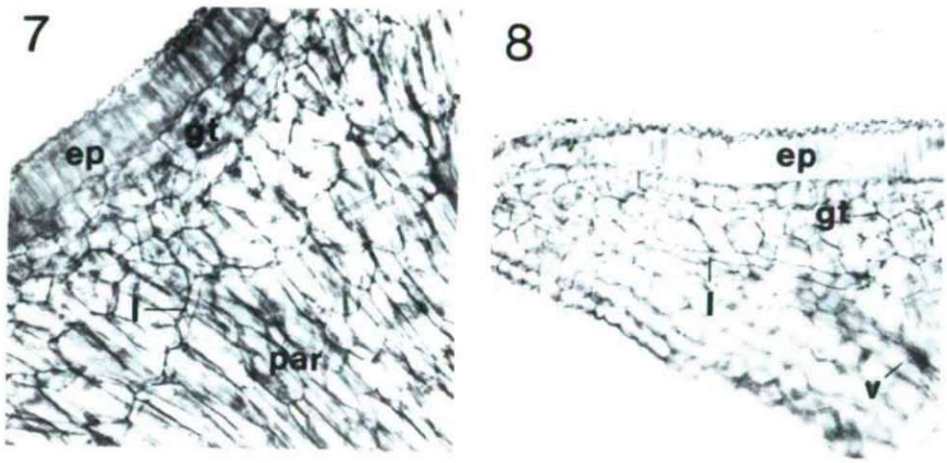

Fig. 7—8.: Longitudinal cuttings of *Euphorbia* nectaries:
7. *E. lucida* 200 X; 8. *E. virgata* 200 X; cuticle (c), epidermis (ep), nectar-secreting pore (sp), nectar-secreting papilla (sep), glandular tissue (gt), laticifer (l), elements of vascular tissue (v), gland-parenchyma (par).

the longitudinal cutting, its cells are expanded in a parallel direction with the elements of the vascular tissue (Fig. 3 and 7), there are small intercellular spaces between them. The parenchyma-cells of *Euphorbia burmannii* compared to those of the other species are large and round. Some of the elements of the vascular tissue that run here end well before the boundary of the glandular tissue and the parenchyma, others can reach the boundary of the two tissues.

Our research on the composition of nectar and latex led to results that suggest a further, functional connection between the two anatomically connected secretion systems. This means that in the nectar secretion certain components of the latex may be secreted into the nectar either transformed or unchanged. We will discuss these results in a later publication.

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EFFECT OF THE HIGH TEMPERATURE ON THE MORPHOLOGICAL CHARACTERISTIC FEATURES OF THE SPOROMORPHS II

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Abstract

Globular surface elements and connections between two pollen grains as new morphological characteristic features were occasionally observed on the pollen grains of *Ginkgo biloba* L. cultivated in Szeged. After the separation of the connected pollen grains, the bases of the connectives are peculiar pores. In contrast to the inter-apertural exine the annulus-like thickenings around the pores stained differently by Toluidin blue.

Preliminary results on the change of the qualitative and quantitative morphological characteristic features in consequence of high temperature effect are also presented herein. Detailed methodological investigations were carried out on two kinds of recent inaperturate pollen grains (*Juniperus virginiana* L., *Taxus baccata* L.). In consequence of high temperature, secondary changes for angiosperm characteristic features appeared on these pollen grains. Monoporate (type Gramineae), tricolpate (early Longaxones, dicotyledonous type), and Brevaxones (plicate forms, Normapolles type) were observed. The frequency distribution of the diameter of the non-experimental, and the different kinds of experiments on the same species are also discussed herein. As an important new parameter the proportion of the data of the non-experimental and the experimental frequency distribution diagnoms are introduced in this paper.

Key words: Palynology, Gymnospermae, monosulcate, inaperturate types, high temperature effect.

Introduction

The pollen grains of the recent gymnosperms may be classified into the following morphological groups: saccate, inaperturate, monosulcate and polyplicate. Between them, probably the saccate type is the earliest (cf. *Archaeoperisaccus* NAUMOVA). TEM data from are MEYER and RASKATOVA (1984), and from MEYER-MELIYAN and TELNOVA (1989).

The first Carboniferous disaccate pollen grains of the genus *Pityosporites* SEWARD 1914 em. MANUM 1960 are characteristic disaccate pollen grains. The importance of the monosulcate gymnosperm pollen grains in the fossil palynomorph record was recognized a long time ago. The Ginkgoalean-Cycadacealean botanical affinity was also discovered. Results on comparative and/or morphological variations of the recent *Ginkgo biloba* L. were published by ERDTMAN (1954, 1957), KEDVES (1961b) and LIEUX (1980). Carbon-replica method for the ultra-relief was first published by ERDTMAN (1965). Using the electron-microscope method, AUDRAN and MASURE (1978) established; p. 363: „The *Ginkgo biloba* sporoderm, when examined

with transmission and scanning electron microscopes, shows a sculpture and texture which are very different from those observed in Cycads." Later the extremely great importance of the monosulcate (-colpate) forms in the evolution of the first angiosperm pollen grains was recognized (cf. DOYLE 1977, HUGHES, DREWRY and LAING, 1979). The phylogenetic significance of the exine ultrastructure, especially of the infratectal layer was emphasized several times by M. VAN CAMPO (1973), M. VAN CAMPO and LUGARDON (1973), and by DOYLE et al. (1975). In this way in several cases on fossil pollen grains, it is the exine ultrastructure only, which may be the unique arbitrary characteristic feature for the separation of the Cycadalean-Ginkgoalean pollen grains from the early angiosperm pollen grains. Following the DOYLE (1977) scheme, from the basic monosulcate type the tricolpate, then the tricolporate may develop. From the tricolporate pollen grains the first brevaxonate pollen grains are appearent. KEDVES (1981); p. 77/78: „The most important changes in the form and symmetry are as follows:

I. Longaxones; monosulcate — tricolpate — tricolporate
II. Brevaxones; tricolporate — triporate, triatriate, etc.
1. Monosulcate — Tricolpate; change in number of the germinal apertures
2. Tricolpate — Tricolporate; change in the character of the aperture
3. Tricolporate Longaxones — Probrevaxones; shortening of the polar axis.

Therefore the three major evolutionary changes in the form and the symmetry of the early angiospermous pollen grains exhibit different characters."

The inaperturate pollen grain types have been several times problematic regarding their botanical affinity: Taxodiaceae, Cupressaceae, Taxaceae, etc. among the gymnosperms, *Cinnamomum, Populus* from the angiosperms, but planctonic organisms may also be taken into consideration. Back up to the monosulcate forms, the inaperturate pollen grains were not believed as important representatives of one step of the angiosperm pollen grains. During our transmission electron microscope investigations, angiosperm type ectexine (without endexine) was found at the peculiar inaperturate pollen grains of *Spheripollenites scabratus* COUPER 1958 (KEDVES and PÁRDUTZ, 1973). Later, inaperturate — monoporate evolutionary lineages were presumed; EL-SAADAWI and KEDVES (1991). The first results about the consequences of high temperature to the morphological characteristic features of some recent brevaxonate pollen grains are published in 1989 (KEDVES and KINCSEK). The aim of our research program has different aspects, namely methodological, taxonomical and phylogenetical. The application of these results to the secondary changes during the diagenesis of the organic material. This paper is the first part of our experimental studies in this field.

Materials and Methods

1. *Ginkgo biloba* L., cultivated in the Garden of the Museum of Szeged, collected by M. KEDVES on 3.4.1989. Fresh pollen grains were stained with Toluidin blue, and mounted in glycerin jelly hydrated of 39,6%.

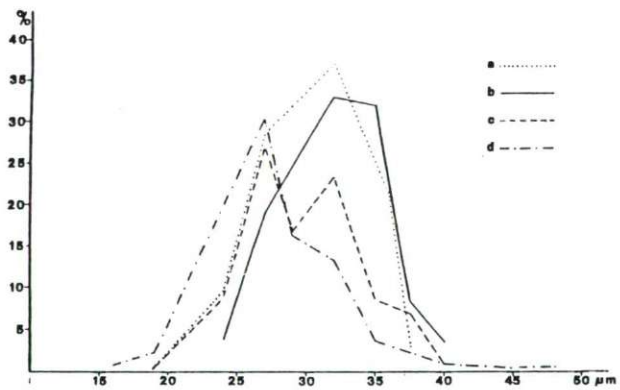
Experiment No 583 — 5 mg air dried pollen grains were heated at +200 °C during one hour.

2. *Juniperus virginiana* L., and *Taxus baccata* L. collected by I. KINCSEK in the Botanical Garden of the A. József University on 14.3.1989. Unstained and pollen grains heated at +200 °C during different hours were examined. The experiments are as follows:

T. baccata	*J. virginiana*	
No of experiment		length of time in hours
491	479	1
492	480	2
493	481	3
494	482	4
495	483	5
496	484	10
497	485	15
498	486	20
499	487	30
500	488	40
501	489	50
502	490	100
	651	125
	652	150

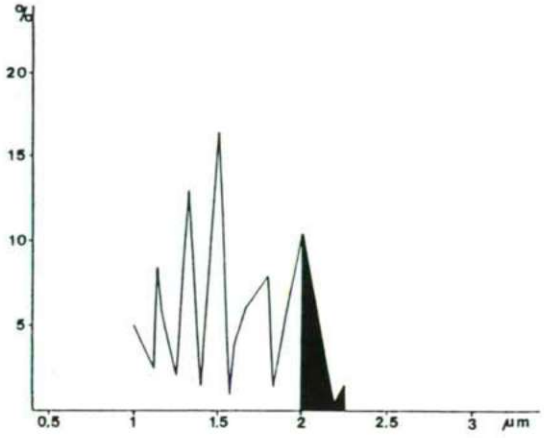
Results

Ginkgo biloba L. (Plate I, II, text-figs. 1—3)



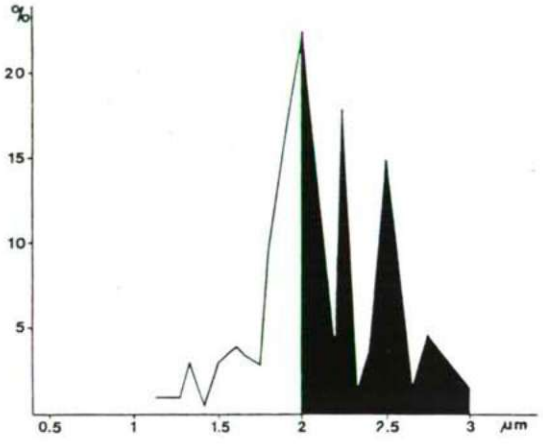
text-fig. 1

Variation-statistical graphs of the polar axis of the pollen grains of *Ginkgo biloba* L.
a: Fresh pollen grains without experiment.
b: Pollen grains after experiment No 583.
c: Acetolyzed pollen grains from Japan.
d: Acetolyzed pollen grains from Hungary.
The last two graphs follow the paper by KEDVES (1961b).



text-fig. 2

Variation-statistical diagram of the polar-equatorial axis ratio (P/E) of the fresh collected pollen grains of *Ginkgo biloba* L. without preparation.



text-fig. 3

Ginkgo biloba L. recent. Variation-statistical diagram of the polar-equatorial axis ratio (P/E) of the fresh collected pollen grains after experiment No 583.

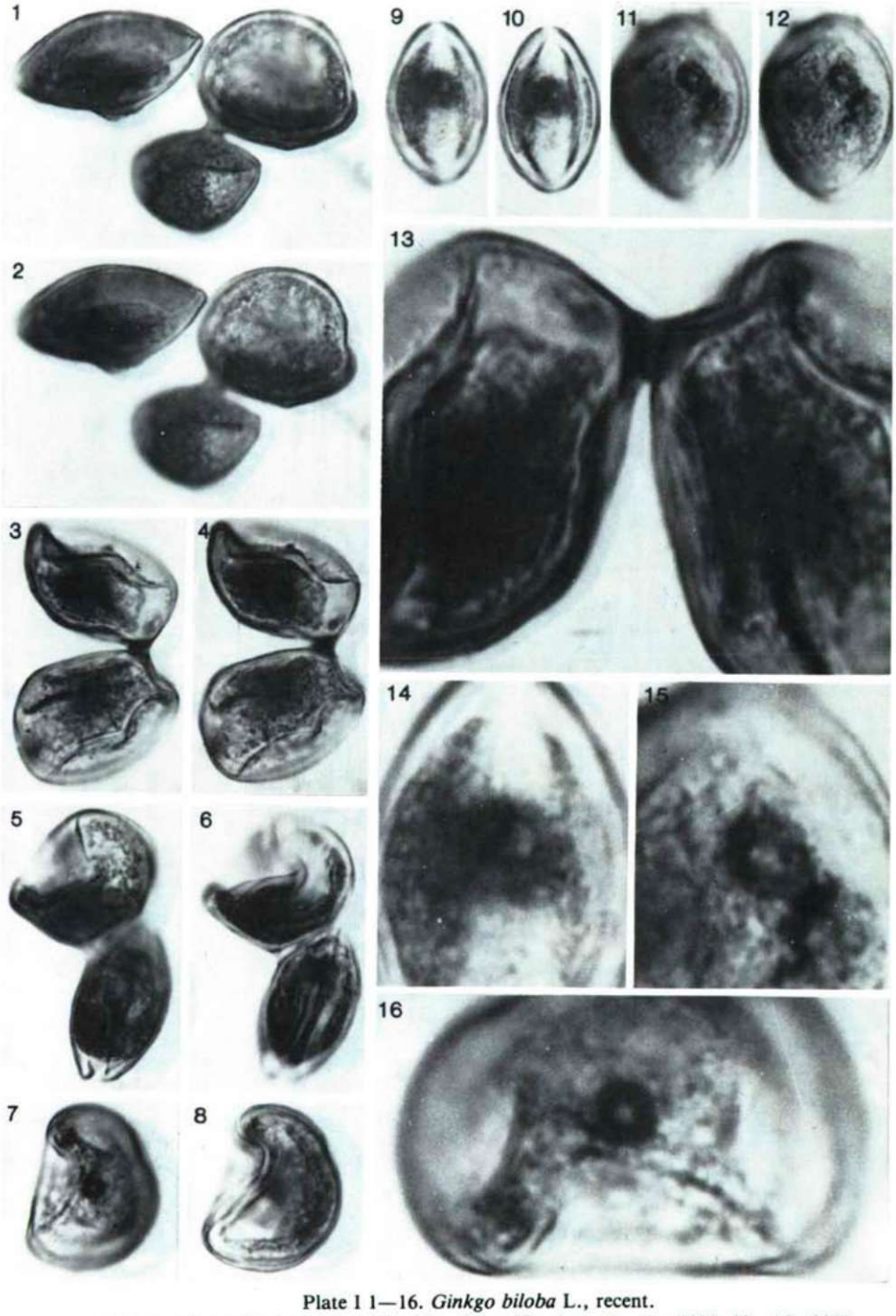


Plate I 1—16. *Ginkgo biloba* L., recent.
Pollen grains stained with Toluidin blue. Magnifications: 1—12×1000, 13—16×3000.

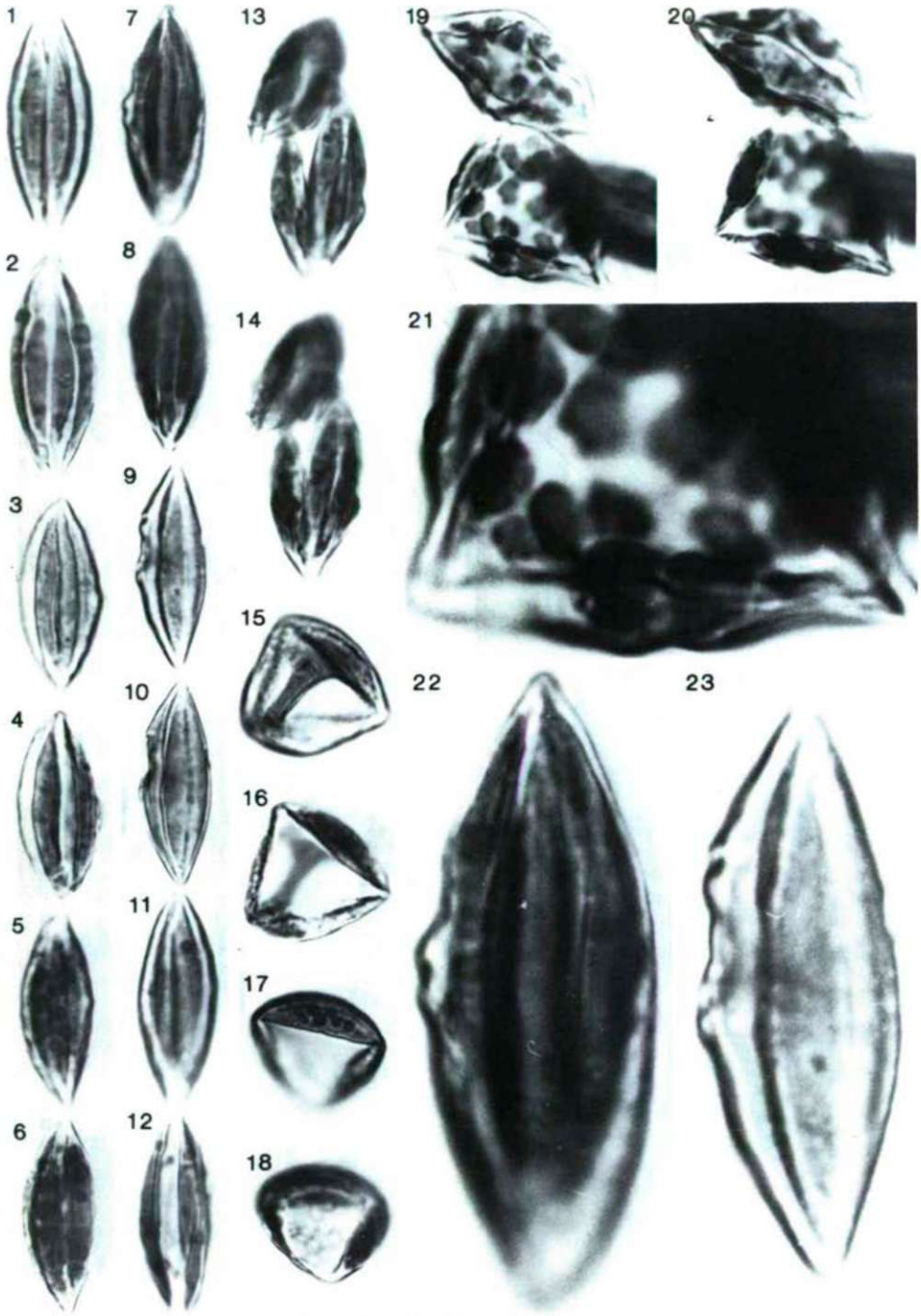


Plate II 1—23. *Ginkgo biloba* L., recent.
Pollen grains after experiment No 583. Magnifications: 1—20 × 1000, 21—23 × 3000.

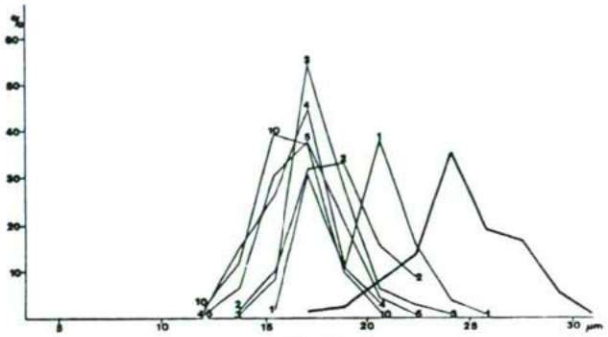
1. New observations on the qualitative morphological characteristic features of this species (Plate I, figs. 1—16). The most important new observations: pollen grains may occur in pairs. The quantity is low, about 1 per cent of the pollen grains investigated (Plate I, figs. 1,2,3,4,5,6, 13). Occasionally more (about three) connections were also observed (Plate I, figs. 5,6). After separation of the two pollen grains pores or pseudopores appear. Their diameter is 0.7—1.5 μm, bordered with irregular „annulus-like" thickening, breadth 1—2 μm. The whole diameter of this „polar area" is 2.8—4.2 μm. (Plate I, figs. 7,8,9—12, 14, 16). With the stain Toluidin blue, the so-called germinal area is violet-coloured, the other parts of the exine are greenish-blue. In this way characteristic difference in the chemistry of the two parts of the exine can be established. On the pollen grains after experiment No 583 several times the pseudo-pore region with annular thickenings may be well shown (Plate II, fig. 7,8,9, particularly 22, 23). The form varieties, similar to the trichotomosulcate forms occur in 2.5 per cent at the pollen grains without experiment, and 4 per cent after experiment. The change in the basic monosulcate morphological characteristic features is well shown on Plate II, figs, 1—14, 22,23. Taking into consideration the Synopsis of POTONIÉ (1958) these forms are similar to the form-genera *Bennettitaceaeacuminella* MALYAWKINA 1953, and *Ginkgoretectina* MALYAWKINA 1953. These are early morphological characteristic features due to the experiment. But as advanced forms the „porate" and the trichotomosulcate-like forms may be pointed out.

2. As regards the length of the polar axis for comparison we used the earlier measurements, too (KEDVES, 1961). Pollen grains from two localities (one from Japan, another from Hungary) both herbarium material were treated with the acetolysis method (ERDTMAN, 1954). Our new data from fresh collected material mentioned previously stained with Toluidin blue and after experiment, No 583 (text-fig. 1). The statistical variety of the polar axis of the acetolyzed pollen grains from the locality of Japan have a graph with two maximums in contrast to the pollen grains collected from Hungarian locality. The recently investigated specimens, without experiment resulted in this respect in a frequency distribution graph with one single peak.

In contrast to this, the pollen grains after high temperature experiment have polar axis maximum between 32—35 μm, so this has, not an expressed maximum at one single value. It is worth of mentioning, that the frequency distribution graphs of the non-experimental, and the acetolyzed pollen grains from Japan are essentially the same, between 17—27 μm.

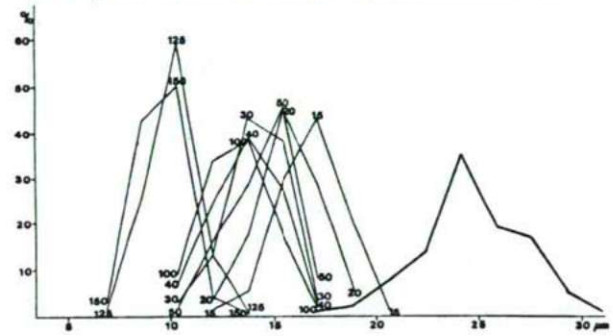
The polar/equatorial axis ratio seems to be a very important characteristic feature in phylogenetical Palynology and/or in experimental respect. For an expressive graph we prepared as follows: (text-fig. 2,3). The per cents of value 2 or more than 2 are represented with black area, the lower than 2 a single graph. At the pollen grains without experiment (text-fig. 2), it can be established the following: 5.0 per cent of the pollen grains are isodiametric. 87.5 per cent of the pollen grains have P/E ratio 2 or lower than 2. After heating, following the experiment No 583, the values are as follows: No isodiametric pollen grain, 71.5 per cent of the pollen

grains have P/E ratio 2 or more than 2. Nearly the opposite to the previous. The pollen grains during one hour at 200 °C, the polar-equatorial axis changed in a significant manner.



text-fig. 4

Juniperus virginiana L., recent. Variation-statistical diagrams of the diameter of the fresh collected pollen grains. Graph with thick line represents the pollen grains without experiment, the other ones the results of experimental investigations on relatively short length of time. Numbers on the graphs indicate the length of time in hours of the experiments at 200 °C.



text-fig. 5

Juniperus virginiana L., recent. Variation-statistical diagrams of the diameter of the fresh collected pollen grains. Graph with thick line represents the pollen grains without experiment, the other ones the results of experimental investigations on relatively long length of time. Numbers on the graphs indicate the length of time in hours of the experiments at 200 °C.

Juniperus virginiana L. (Plate III, text-figs. 4,5)

The fresh collected pollen grains (Plate III, fig. 1) are spherical apparently inaperturate the pseudo-pores (M. VAN CAMPO-DUPLAN, 1953) are in several cases not so well discernible. On the pollen grains of non-experimental sample, no new supplementary qualitative morphological characteristic features have been observed, in contrast to the previously discussed species.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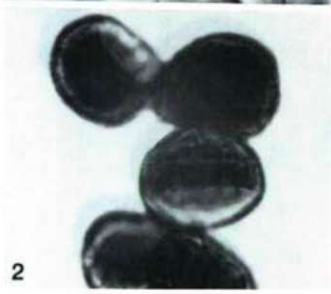
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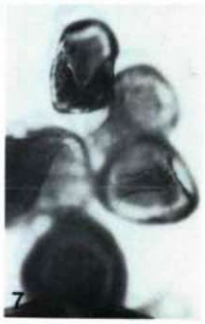
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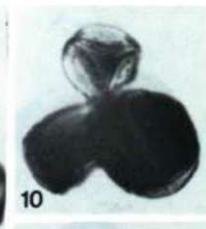
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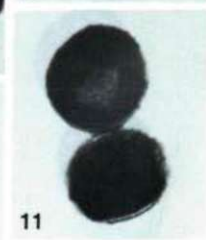
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Plate III

Plate III

1—24. *Juniperus virginiana* L., recent.
1. Pollen grains without stain and experiment.
2—4. Pollen grains after experiment No 479.
5—7. Pollen grains after experiment No 480.
8, 9. Pollen grains after experiment No 481.
10, 11. Pollen grains after experiment No 482.
12, 13. Pollen grains after experiment No 483.
14, 15. Pollen grains after experiment No 484.
16—18. Pollen grains after experiment No 485.
19—21. Pollen grains after experiment No 486.
22—24. Pollen grains after experiment No 487.
Magnification: ×1000.

After the experiments at high temperature at +200 °C by different length of time several qualitative morphological changes have been observed. These secondary morphological characteristic features rank as follows:

1. New basic morphology, inside the so-called inaperturate gymnosperm pollen grains: the „cup form", which is common at some Taxodiaceae pollen grains.

2. Secondary morphological characteristic features, which are similar to the angiosperm pollen grains:

2.1. Plicate forms, similar to the early Normapolles pollen grains (extinct Dicotyledonous pollen grains from the Upper Cretaceous) or to the trilete spores (Plate III, fig. 6,7,10, plate IV, fig. 19, 22 ,23 — the pollen grain in the upper left corner of the picture).

2.2. Inside the plicate forms „tetraexitus" (Plate III, fig. 15,23, plate IV, fig. 2,12,16) and „pentaexitus" types (Plate III, fig. 12,23), were also observed.

3. „Tricolpate forms" (Plate IV, fig. 6,9,15,20,21).

Plate IV

1—23. *Juniperus virginiana* L., recent.
1—3. Pollen grains after experiment No 488.
4—6. Pollen grains after experiment No 489.
7, 8. Pollen grains after experiment No 490.
9—15. Pollen grains after experiment No 651.
16—18. Pollen grains after experiment No 652.
Magnification: ×1000.
19. Enlarged part of photo 10, plate III; experiment: No 482.
20. Enlarged part of photo 10, plate IV; experiment: No 651.
21. Enlarged picture of photo 15, plate IV; experiment: No 651.
22. Enlarged picture of photo 13, plate III; experiment: No 483.
23. Enlarged picture of photo 6, plate III; experiment: No 480.
Magnification: ×3000.

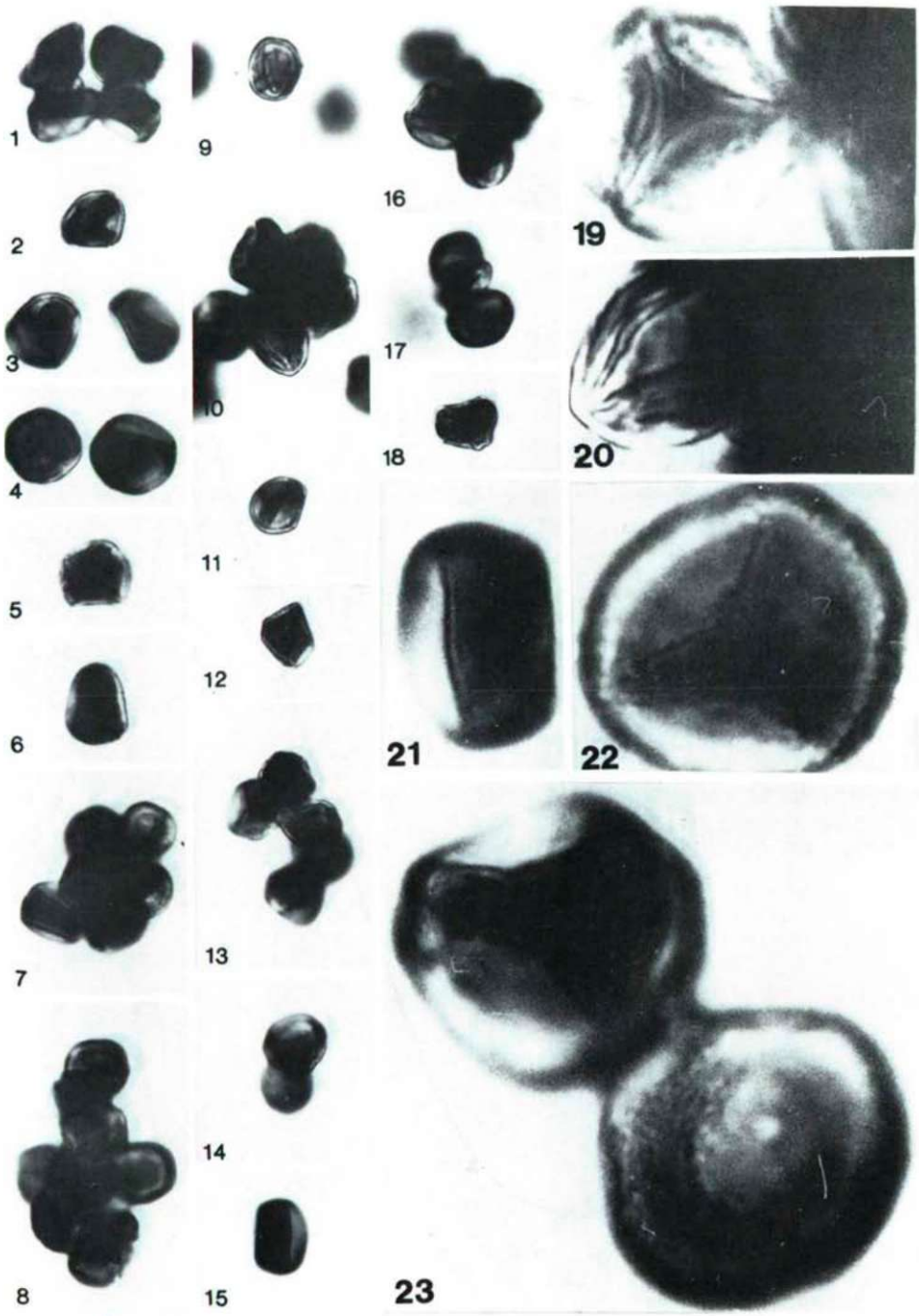


Plate IV

4. „Gramineoid-like" monoporate forms (Plate III, fig. 6, and plate IV, fig. 23, the lower right pollen grain).

As regards the changes in size, at this species the different dimensions of pollen grains are represented in text-figs 4, and 5. The basic data, e.g. the variation-statistical graph of the pollen grains without experiment are represented with thick line. Diameter from 17.24 μm to 31.03 μm, maximum, 35.0 per cent at 24.13 μm. The graph have a striking single maximum. At experiment No 479, two maximum values were established. Experiments No 480 and No 484 resulted in not conspicuous maxima, there are two higher values near of the same per cents, 31.5 resp. 33.0. At experiments 481, 482, 485, the maxima are on the same diameter, but the per cent values diminish nearly regularly; 55.0, 45.0, 37.5. It is also worth of mentioning that this size is identical with the smallest pollen grain from the non-experimental sample, 17.24 μm. Moreover this value is the same as the second maximum of experiment No 479. Experiments No 485—490 (text-fig. 5)

The maximum diameter values of the experiments of 15 and 20 hours (No 485, 486) are inside the minimum—maximum value distance of the non-experimental sample. We emphasize that the largest forms after heating at 30, 40, 50 and 100 hours are on the same value, which is identical with the smallest pollen grains of the basic non-experimental samples.

It may be mentioned, as an important phenomenon, that the great change in the diameter of the pollen grains happened between the experiments of 100 and 125 hours. The largest size, after heating for 125 hours is much more smaller than at 100 hours. In this way the point of separation of the non-experimental and experimental variation-statistical graphs is between 100 and 125 hours. It is also worth of mentioning that the experiment at 150 hours resulted in not so much news, the minimum/maximum values are identical. Regarding the characters of the variation-statistical graphs, not explicite maxima were observed at the experiments at 30, 100, and 150 hours. Finally, it is also important that the graphs of the experiments at 125 and 150 hours are distinct from all the previous ones.

Plate V

1—22. *Taxus baccata* L., recent.
1. Pollen grains without stain and experiment.
2—4. Pollen grains after experiment No 491.
5—7. Pollen grains after experiment No 492.
8—10. Pollen grains after experiment No 493.
11—13. Pollen grains after experiment No 494.
14—16. Pollen grains after experiment No 495.
17—19. Pollen grains after experiment No 496.
20—22. Pollen grains after experiment No 497.
Magnification: ×1000.

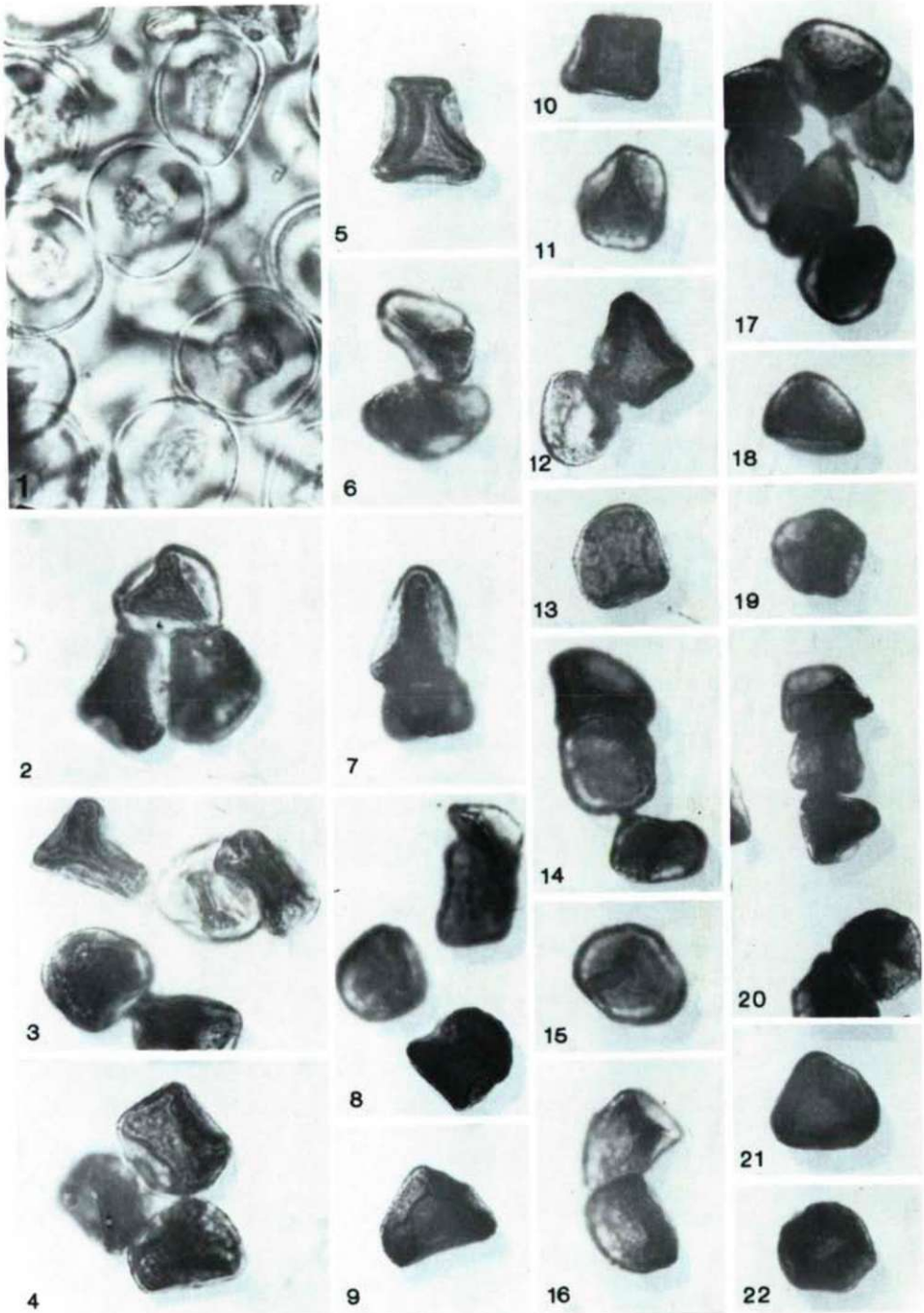


Plate V

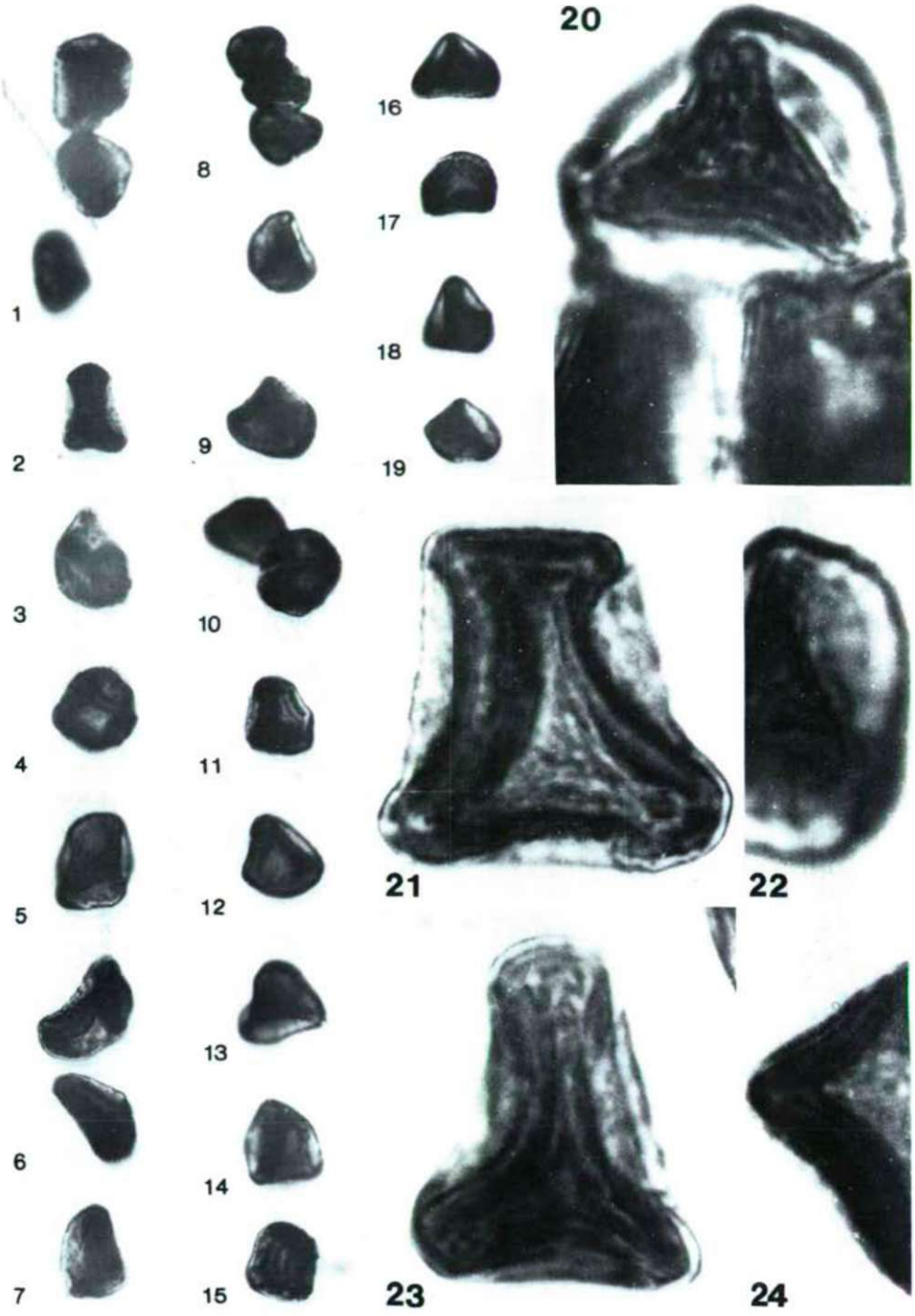


Plate VI

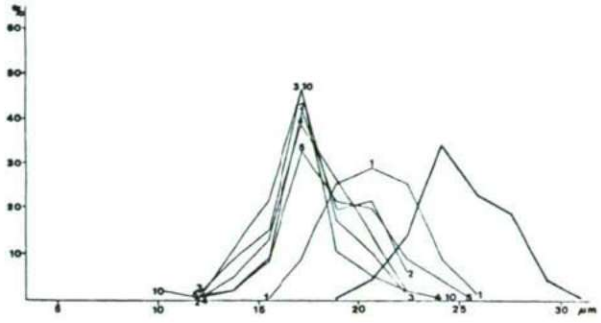
Plate VI

1—24. *Taxus baccata* L., recent.
1—3. Pollen grains after experiment No 498.
4—7. Pollen grains after experiment No 499.
8—11. Pollen grains after experiment No 500.
12—15. Pollen grains after experiment No 501.
16—19. Pollen grains after experiment No 502.
Magnification: × 1000.
20. Enlarged part of photo 2, plate V; experiment: No 491.
21. Enlarged picture of photo 5, plate V; experiment: No 492.
22. Enlarged part of photo 11, plate V; experiment: No 494.
23. Enlarged part of photo 3, plate V; experiment: No 491.
24. Enlarged part of photo 12, plate V; experiment: No 494.
Magnification: × 3000.

Taxus baccata L. (Plate V, VI, text-figs 6,7)

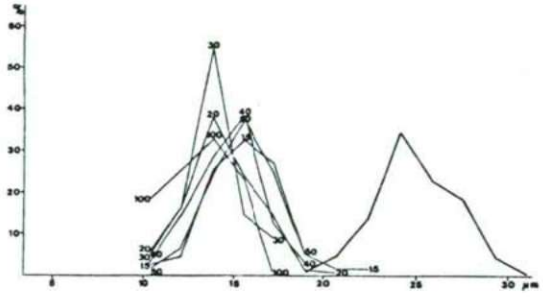
The fresh collected pollen grains without any treatment regarding their most important morphological characteristic features are identical with the previously discussed species. The qualitative changes in the morphological characteristic features in consequence of the experiments are also not so different from the pollen grains of *Juniperus virginiana* L. The most important secondary forms are almost exclusively plicate „Normapolles-like" types. These forms are in some cases really so similar to the early extinct brevaxonate pollen grains that at the fossil forms it is too difficult to distinguish the real angiosperm and the secondary forms of inaperturate gymnosperm pollen grains. At the terminal parts of the secondary plicae of our pollen grains pores or pseudopores may also occur (Plate V, fig. 2, plate VI, fig. 20, 23, etc.). Between these forms two types may be distinguished, the so-called „*Plicapollis* form" which is the most frequent, and the „*Interpollis* type" (Plate VI, fig. 24). So-called „tetraexitus form" was also observed (Plate V, fig. 4, 12, 13).

Our results concerning the quantitative changes in consequence of the experiments (text-figs 6, 7) may be summarized as follows:



text-fig. 6

Taxus baccata L., recent. Variation-statistical diagrams of the diameter of the fresh collected pollen grains. Graph with thick line represents the pollen grains without experiment, the other ones the results of experimental investigations on relatively short length of time. Numbers on the graphs indicate the length of time in hours of the experiments at 200 °C.



text-fig. 7

Taxus baccata L., recent. Variation-statistical diagrams of the diameter of the fresh collected pollen grains. Graph with thick line represents the pollen grains without experiment, the other ones the results of experimental investigations on relatively short length of time. Numbers on the graphs indicate the length of time in hours of the experiment at 200 °C.

The basic variation-statistical graph of the pollen grains, without experiment are represented as previously with thick lines. Diameter from 18.96 μm to 31.03 μm, maximum. 34.5 per cent at 24.13 μm. In this case the graph has a characteristic maximum. After heating at 200 °C during one hour, an important change may be established (text-fig. 6). The maximum of the graph is not so characteristic, there are two values (18.96, 22.41 μm) the same per cent, and the difference between these values, and the maximum is 3.50 per cent only. It is also worth of mentioning that the experiments during 2, 3, 4, 5, and 10 hours, at 200 °C have the maximum on the identical value of diameter (17.24 μm). The changes are not regular in contrast to

the previously investigated species. Pollen grains of the experiments of 3 and 10 hours are of the same per cent, this is followed by the 2, 4, and 5 hours. In this way in contrast to the diameter of the fresh material, remarkable change is at 1 hour of heating, the further ones, untill 10 hours are near at the same variation-statistical value. The variation-statistical graph of the experiment during 15 hours is a little similar to those of 1 hour. Here also two values (13.79, 17.24 μm) are almost identical, and the differences in the maximum are 7.0 and 5.5 per cent. The maxima of the experiments of 40 and 50 hours is at this diameter. The two latter are near at the same value. Another group is the 30, 20 and 100 hours of experiments from the point of view of the maxima of the graphs. It is interesting that the minimum diameter is at the same value 13.79 μm. Changes in the per cents are irregular, they increase as follows: 50, 15, 40, 30, 20 and 100 hours. As regards the maxima of these experiments those during at 15 and 20 hours are in the dominion of the non-experimental pollen grains.

The maximum diameter of the experiments of 40 and 50 hours are at the minimum value of the non-experimental material. The separation of the graphs, in contrast to the previously mentioned species in between 50—100 hours.

Discussion

1. Concerning the new morphological characteristic features observed on the pollen grains of the recent *Ginkgo biloba* L., we may presume the following:

The connections between gymnosperm pollen grains in tetrad may be considered as an early morphological characteristic feature. TREVISAN (1971) described peculiar interconnections between the pollen grains of *Dicheiropollis etruscus* n.gen. et sp. from the Cretaceous layers of Tuscany, Italy. Similar connections between *Classopollis* pollen grains are represented in fig. 1, Plate X, and at the tetrad of *Callialasporites* in fig. 4, plate XII, by BALDONI and ARCHANGELSKY (1983). This early morphological characteristic feature was well elaborated by COURTINAT (1980) at the pollen grains of the genus *Classopollis* PFLUG 1953. The connections between the pollen grains were named as „pont". The filaments in the triangular tetrad squar „brachyosomes", when these filaments joint two pollen grains as „dolichosome". The globular surficial elements around the triangular squareas „pleurospheres". In this way the connections observed by us at the recent *Ginkgo biloba* L. may be analogues or identical with the „pont" of COURTINAT (1980). The spherical bodies around the apertural zone correspond to the „pleurospheres" those on the distal surface as „ataxospheres". But taking into consideration the publication of TAYLOR and ALVIN (1984) concerning the exine ultrastructure evolution of the *Classopollis* type pollen grains, it may be presumed that these are orbiculi (Ubisch bodies). Till this time these morphological characteristic features were not observed at the recent and fossil Ginkgoalean pollen grains. Based on the fact that the monosulcate pollen type is earlier (Paleozoic) than the *Classopollis*, *Dicheiropollis Callialasporites* (Early Mesozoic) these primary and/or secondary morphological characteristic features are advanced.

The secondary angiospermid characteristic features at the recent pollen grains of the genera *Juniperus* and *Taxus* are also without doubt advanced characters. We presumed that the inaperturate pollen type (including the gymnosperm and angiosperm taxa) has more much phylogenetical importance as we previously believed.

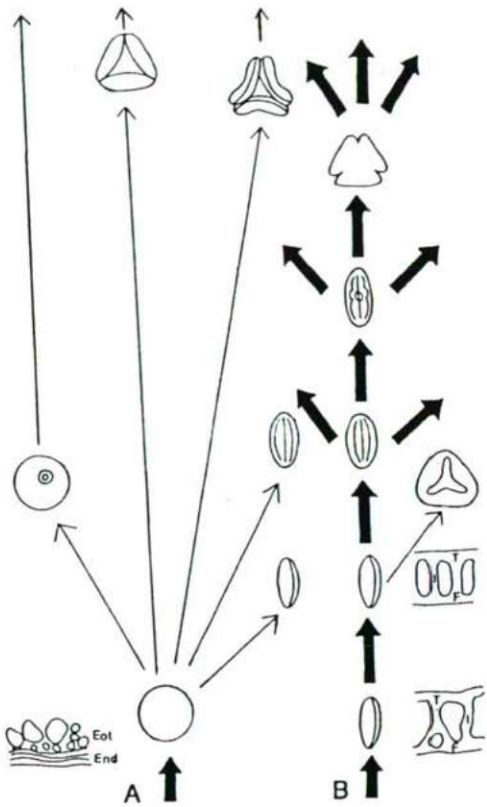
Regarding the methodological problems we must point as follows:

1. It seems that for the inaperturate pollen grains the high temperature effect experiments are in general elaborated, for LM observations. TEM studies must be projected later. The partion of the variation-statistical graphs seems to be important. This is really significantly different between the two species investigated (*Taxus baccata* L.: 50—100 hours, *Juniperus virginiana* L.: 125—150 hours).

2. It is probably important to investigate the changes within one hour, by 5 or 10 sec. This will be the subject of further methodical studies. But on the basis of our up-to-date knowledge, the most important changes in the morphological characteristic features which are important from taxonomical and phylogenetical point of view, appear after heating at 200 °C during one hour. Because this, for the first attempt this method was used at the pollen grains of *Ginkgo biloba* L. On the other hand, as it was emphasized earlier, the methods concerning the monosulcate forms or in general at the Longaxones pollen grains may not be taken as a settled, and completely elaborated problem. It seems that the methodical problems of the high temperature effect at the Longaxones gymnosperm and angiosperm pollen grains are much more difficult and different than at the inaperturate forms. Further sporomorph types (trilete, monolete spores, further gymnosperm, e.g.: saccate, and angiosperm pollen grains) are under elaboration in this respect. The spores with perine, and with elateres (*Equisetum*) are particularly interesting.

Our new results carried new supplements to the evolution of the angiosperm pollen grains (text-fig. 8). So, there are at least two early basic types, the monosulcate (+colpate), and the inaperturate. The heterogeneous origin of for example early brevaxonate pollen grains, and its great diversity in form, shape, sculpture, etc. It is also worth of mentioning that the angiosperm pollen grains in consequence of the high temperature effect resulted earlier forms and types in contrast to the present results of the gymnosperm pollen grains. The preliminary observations on the recent spores of *Equisetum arvense* L., and further Filicinae spores with perispore resulted that these spores lost the elateres, respectively the perispore. In this way earlier types appear. There is a number of problems to be solved in the future in this respect.

3. It is also worth of mentioning that at the fossil pollen grains, during the diagenesis secondary forms may appear. This problem was first investigated circumstantially at the spores, nearer the trilete-triplane-poroplane form-varieties (PFLUG, 1953) were believed as evolutionary lineage. Later, on the basis of the results on recent trilete spores it was established that these diversities may appear during the preparation method, or other influences (cf. DEÁK, 1959, KEDVES, 1960, 1961a, etc.). The form-varieties of further Schizaeaceae spores were described by KEDVES and JURAY (1968).



text-fig. 8

Scheme of secondary forms of the investigated inaperturate gymnosperm pollen grains important from the evolutionary point of view (A) in comparison with the „DOYLE' s scheme" (B) about the most important steps of the angiosperm pollen grains. The light microscopical data are completed by the most important TEM characteristic features.

4. Finally we need to emphasize that the effect of high temperature on the spores and pollen grains may not be confound with the harmomegathy established first by WODEHOUSE (1935), because in this case the changes of the turgescence and non-turgescence conditions are the subject of investigation. It seems that the results of further researches will be important in phylogenetical and taxonomical point of view of the sporology.

Acknowledgements

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CONIFER WOOD FROM NEW SITES OF GANGAPUR FORMATION, INDIA

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Abstract

Investigation of fossil woods from new locations, namely; Yamanpalli and Godepalli have depicted for the first time, the occurrence of two wood genera: *Araucarioxylon* and *Podocarpoxylon* from Gangapur Formation in Pranhita — Godavari Graben. This finding supports that the conifers were the significant part of the vegetation in the mid part of Mesozoic. Of the conifers dominated floral assemblage, *Podocarpaceae* appeared to be the commonest family because of its representation enormously in the form of its leaf, wood and palynomorph.

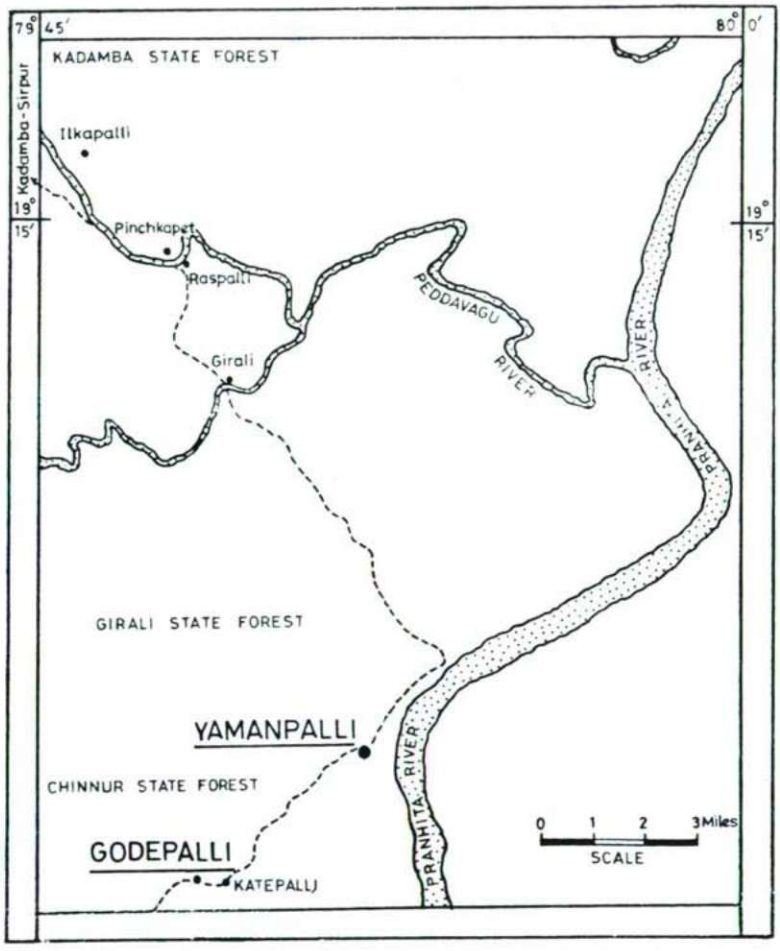
Key words: Xylotomy, fossil, Lower Cretaceous, India.

Introduction

Plant bearing beds from Gangapur Formation have been known to occur since KING (1881) enlisted the fossil plants, viz, *Taeniopteris, Ptilophyllum, Elatocladus, Cheirolepis* and *Araucarites*. After a long hiatus, KUTTY (1969) initiated the search in the same area and while dealing with the stratigraphy of the Upper Gondwana formations recognized Gangapur Formation entirely upon the basis of floral fossils. Gangapur Formation unconformably overlies Kota Formation therefore the author separated the flora of Gangapur and adjacent beds from Kota Formation assessed the age to be of Middle-Upper Jurassic. Following this comprehensive report, RUDRA (1972, 1982) also presented a systematic account of Upper Gondwana stratigraphy and sedimentation of Pranhita — Godavari Valley and during the survey, he could identify Gangapur Formation near Yamanpalli in the eastern part of the outcrop bearing some calcareous fossil wood. However, author did not give the details of the plant remains. Subsequently, BOSE et al. (1982) described mega- and palynofossils from Gangapur Formation. The fossil assemblage is composed of ferns, cycadophytes and conifers. Notable among these floral constituents are: *Gleichenia nordenskioildii, Taeniopteris, Ptilophyllum cutchense, Elatocladus kingianus* and *Pagiophyllum marwarensis*. Besides, palynofossil comprise about 64 taxa out of which the dominant component is the *Araucariacites — Callialasporites* complex and stratigraphically important forms occurring in microflora are: *Trilites tuberculiformis, Ischyosporites crateris, Cooksonites variabilis,* and *Microcachridites antarcticus*. These authors considered the age of these outcrops upon mega-micro-

floral evidence somewhere near Jurassic — Cretaceous boundary probably within the Lower Cretaceous. Further upon palynological investigations RAMANUJAM et al. (1979, 1980) have affixed the age Lower Cretaceous (= Neocomian) for Gangapur Formation. Lately, RAO et al. (1983) confirmed the observations made by earlier workers regarding the dominant and stratigraphically significant palynomorphs. SUKH-DEV and RAJNI KANTH (1988) made further additions of plant megafossils and confirmed the age Lower Cretaceous for the Gangapur Formation.

Lithologically, Gangapur Formation is made up of conglomerates sandstone and shale (KARUNAKARAN, 1975). Sandstone is ferruginous and bears underlying Kota

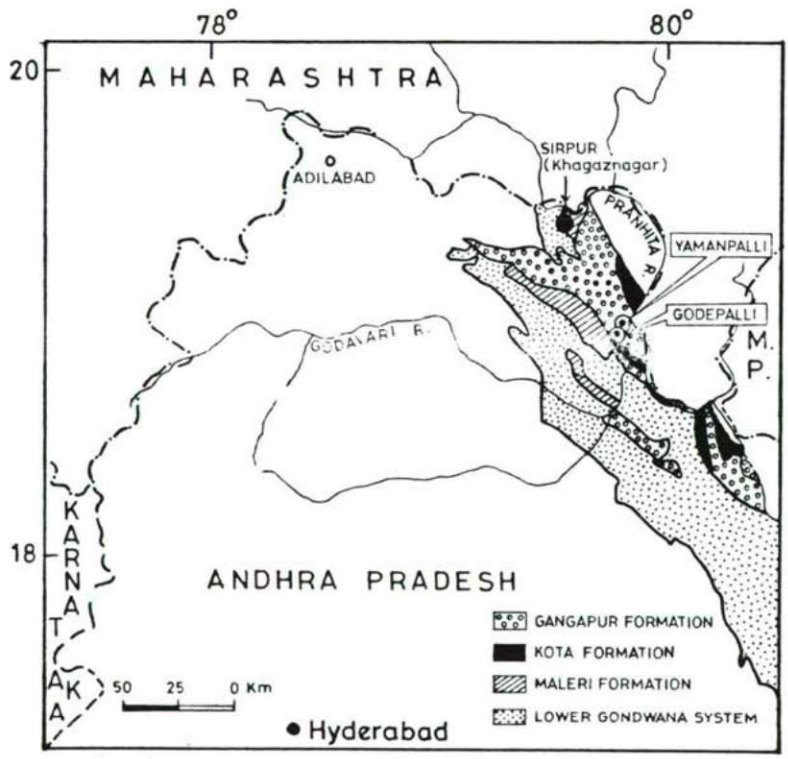


Text-fig. 1.
Map showing fossil localities /after Toposheet No. 56 $\frac{M}{16}$ Chanda-Adilabad District, Andhra Pradesh, India.

fossil plants. Plant fossils are particularly found in finer sediments, namely, mudstone, siltstone and the carbonaceous shale but fragments of fossil woods are found littered or embedded in sandstone.

The present floral collections comprising mainly the petrified woods have been made from the outcrop located near Yamanpalli (79°50′58″: 19°6′) and Godepalli (= Gundepalli, 79°47′48″: 19°4′), Kadamba Block, Kagaznagar, Adilabad District, Andhra Pradesh. These new sites also lie under Gangapur Formation and the occurrence of these woods in plenty has confirmed the observations made earlier for the extension of Gangapur Formation in the eastern part of Pranhita Godavari Graben.

The anatomical studies of these petrified woods have revealed the presence of two families of Coniferales, viz., *Araucariaceae* and *Podocarpaceae* which have been represented by genera *Araucarioxylon* and *Podocarpoxylon* respectively.



Text-fig. 2.
Map showing Gondwana formations of Pranhita-Godavari Graben, Adilabad District, Andhra Pradesh. (Drawn after Dr. M. K. ROY CHOWDHURY, Director General, Geological Survey of India. Geological and Mineral Map of Andhra Pradesh, 1973, refer. Karunakaran, 1975).

Results

TAXONOMY

Order: *CONIFERALES*
Family: *Araucariaceae*

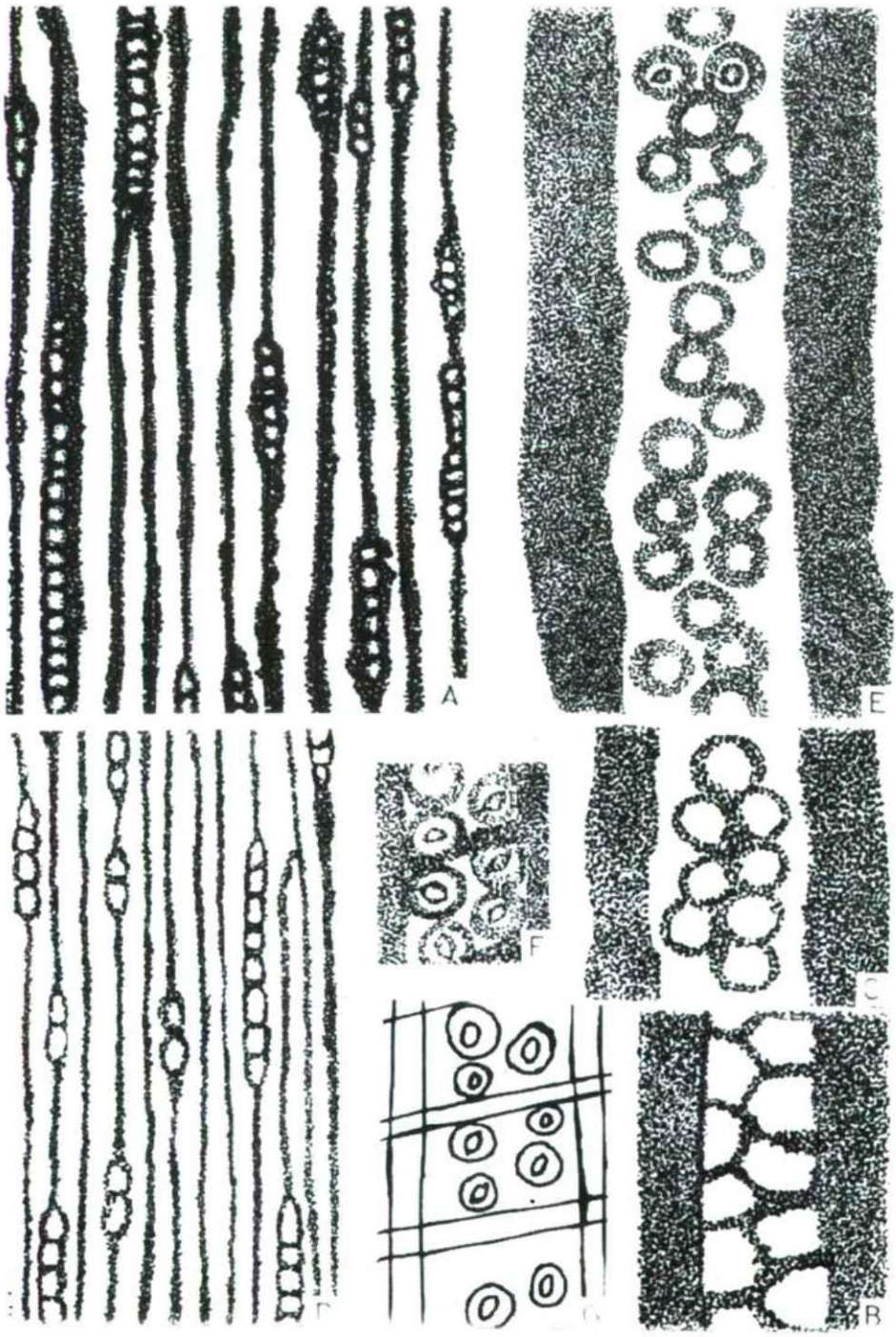
Araucarioxylon amraparense (SAH and JAIN)
BOSE and MAHESHWARI

(Pl. I, figs. 1—6; Text-figs. 3A, B)

Description — Growth rings measures 3800 μm to 3960 μm in width but usually indistinctly marked by thin bands of late wood tracheids. Late wood zone 60 μm to 90 μm in width, or 2—3 cells wide, cells are 16 μm to 20 μm in diameter, tangentially flattened, compactly arranged squarish to rectangular, thick-walled cells in radial rows. Early wood contributes more than 70% of the growth ring, ranges from 85 to 105 cells wide, tracheids comparatively thin walled, oval, squarish to polygonal in shape arranged in radial rows, radial diameter 40—60 μm, tangential diameter 30—40 μm, tangential wall of tracheids usually smooth but their radial walls show pitting and pits numerous, uniseriate or biseriate, alternate, contiguous, hexagonal in shape about 16 μm in diameter, having oval to circular orifices, 4—6 μm in diameter; parenchyma and Bars of Sanio absent; xylem rays numerous, 4—6 per milimeter, uniseriate, 16 μm wide and varying from 2 to 10 cells or 40—245 μm high (represented in the form of elongated barrel-shaped cells in tangential section), pits in the cross-field not observed.
Syntype — B. S. I. P., Slide No. 35603.
Locality — Yamanpalle, Gangapur Formation, Pranhita Godavari Graben Adilabad District.
Age — Lower Cretaceous.

Text-fig. 3.

A. *Araucarioxylon amraparense* SAH and JAIN 1964; tangential longitudinal section showing uniseriate xylem rays. Slide No. 35 603—II, × 100.
B. Radial longitudinal section showing biseriate, alternate, hexagonal pitting. Slide No. 35 603—III, × 500.
C. *Araucarioxylon* sp., radial longitudinal section showing biseriate, circular pitting. Slide No. 35 865—III, × 500.
D. *Podocarpoxylon* sp. tangential longitudinal section showing uniseriate xylem rays. Slide No. 35863—II, × 100.
E. Radial longitudinal section showing circular pitting. Slide No. 35 864—III, × 500.
F. *Podocarpoxylon parthasarthyi;* radial longitudinal section showing cross-field pitting. Slide No. 35 855—III, × 500.
G. Radial longitudinal section showing oblique apertures in the cross-field pitting. Slide No. 35 855—III, × 500.


A
E
F
C
B

Remarks — Identical woods have been reported from the adjacent locality Godepalli but because of lack of district growth rings, these specimens have not been included under *A. amraparense* rather have been treated here as *Araucarioxylon* sp. (Text-fig. 3C). However, their occurrence in this particular locality is quite meagre. MAHESHWARI (1972) has identified both genera *Dadoxylon* and *Araucarioxylon* on the basis of secondary wood only. According to him *Araucarioxylon* is characterized by uniseriate xylem rays and *Dadoxylon* by multiseriate xylem rays. In view of the diagnosis of the two genera, most of the araucarian woods described earlier under the name *Dadoxylon* have not been transferred to *Araucarioxylon* (BOSE and MAHESHWARI, 1974). The present wood differs from *Araucarioxylon agathioides* (KRÄUSEL and JAIN) BOSE and MAHESHWARI, in the absence of pits having cross-shaped aperture and 2—8 cross-field pits. *Araucarioxylon bindrabunense* (SAH and JAIN 1964) comb. nov. also differentiates itself in the character of 1—45 cells high medullary rays and 4—12 bordered pits in the cross-field area. From the *Araucarioxylon mandroense* SAH and JAIN 1964 comb. nov., present wood can be distinguished by the character of distinct growth rings and distinct cross-field pits in the early and late wood tracheids. *Araucarioxylon rajmahalense* SAHNI, 1931, possesses distinct 2—3 radial pitting in early wood and uniseriate pitting in the late wood. *Araucarioxylon santalense* SAH and JAIN, 1964, has got microscopically indistinguishable growth rings and 2—6 cross-field pits, however, this feature completely lacks in the present wood. The present wood resembles most to *Araucarioxylon amraparense* SAH and JAIN 1964 in general specific characters, described from Amrapara, Rajmahal hills, Bihar.

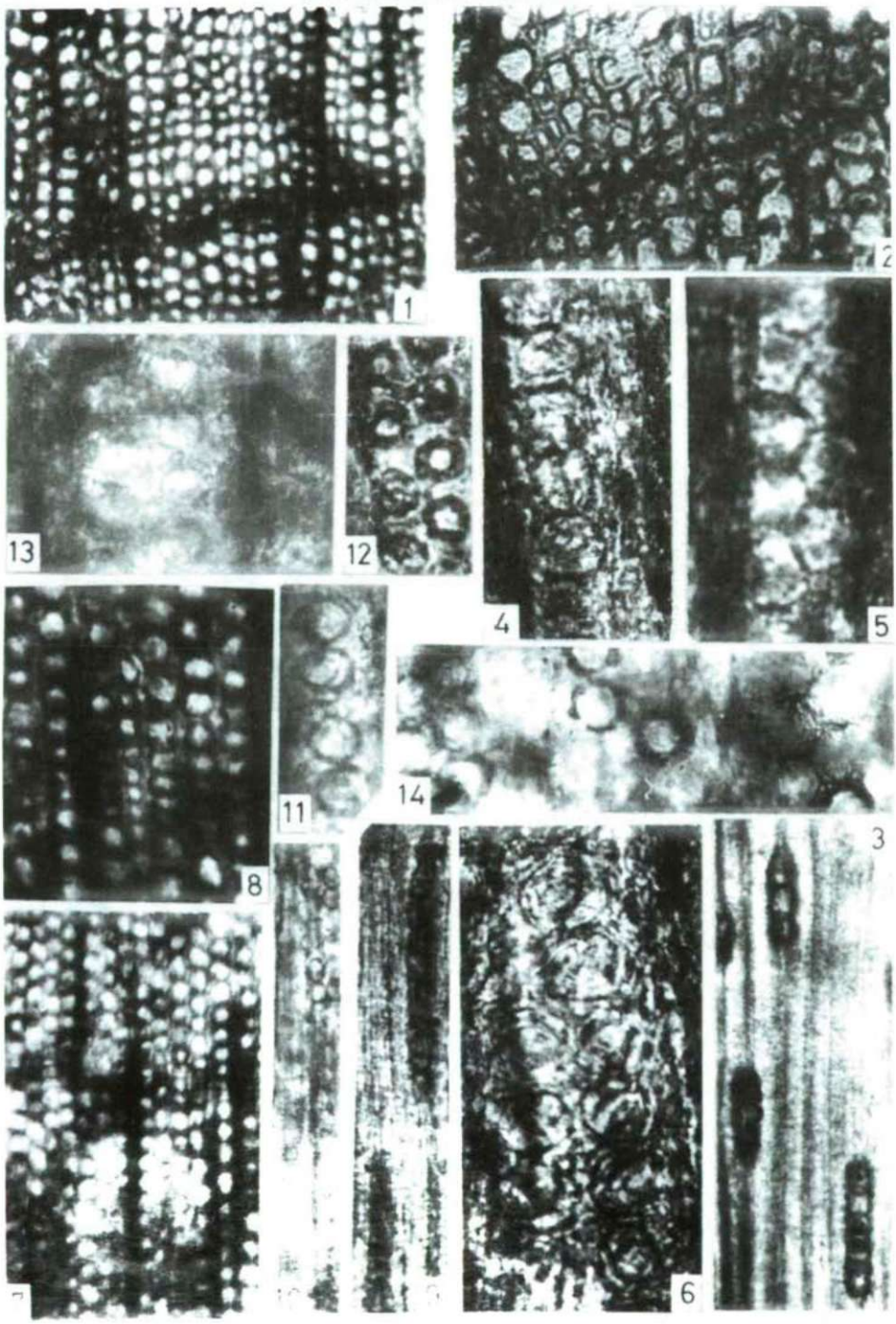
Plate I

1—6. *Araucarioxylon amraparense* SAH and JAIN 1964.

1. Cross-section showing growth rings with early and late wood. BSIP Slide No. 35 603—I, ×50.
2. Cross-section magnified to show early wood and late wood. BSIP Slide No. 35 603—I, ×100.
3. Tangential longitudinal section showing uniseriate xylem rays. BSIP Slide No. 35 604—II, ×100.
4. Radial longitudinal section showing uniseriate, hexagonal, contiguous pits. BSIP Slide No. 35 602—III, ×500.
5. Radial longitudinal section showing biseriate, alternate, hexagonal pits. BSIP Slide No. 35 603—III, ×500.
6. Radial longitudinal section showing circular pitting tending to be arranged in parallel rows. BSIP Slide No. 35 605—III, ×500.

7—14. *Podocarpoxylon parthasarthyi* SAHNI 1931.

7. Cross-section showing growth ring with early and late wood. BSIP Slide No. 35 855—I, ×50.
8. Cross-section magnified to show early wood and late wood. BSIP Slide No. 35 855—I, ×100.
9. Tangential longitudinal section showing xylem rays. BSIP Slide No. 35 856—II, ×100.
10. Tangential longitudinal section showing pitting. BSIP Slide No. 35 856—II, ×200.
11. Radial longitudinal section showing uniseriate, circular pitting. BSIP Slide No. 35 855—III, ×500.
12. Radial longitudinal section showing biseriate, circular pits. BSIP Slide No. 35 856—III, ×500.
13. Radial longitudinal section showing pits in the cross-field area. BSIP Slide No. 35 855—III, ×500.
14. Radial longitudinal section showing solitary, circular pits tending to be arranged alternate appearing hexagonal due to compression. BSIP Slide No. 35 856, ×500.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The radial pitting in the present fossil wood shows typically araucaroid pitting having hexagonal, alternate, contiguous pits. However, at places the radial pits tend to be opposite and circular. Such a pitting is also reported in *A. amraparense*. Like *A. amraparense,* rays are uniseriate, 2 to 10 cells high. Cross-field pits are not observed in the present fossil wood due to ill-preservation.

On account of the presence of above said characters the present wood has been placed under *Araucarioxylon amraparense* (SAH and JAIN) BOSE and MAHESHWARI, 1974.

Family: *Podocarpaceae*

Podocarpoxylon parthasarthyi (SAHNI) BOSE and MAHESHWARI

(Pl. I, figs. 7—14; Text-figs. 3F, G)

Description — Growth rings presents but not conspicuous, indistinctly marked by late wood tracheids. Late wood zone 80 to 90 μm or 3—4 cells wide comprising compactly arranged tangentially flattened rectangular thick-walled tracheids of 18 μm in diameter. Early wood zone quite wide consisting of 20 to 50 tracheidal cells, tracheids comparatively thin walled, oval, circular or polygonal with wide lumen arranged in radial rows, radial diameter 42—50 μm and tangential diameter 28—40 μm, tangential wall usually smooth, but rarely it shows circular pitting, rays frequency 4—6 rays/mm. Xylem rays uniseriate, rarely biseriate, 1 to 20 cells or 30 to 550 μm in height, pits numerous, mostly uniseriate, biseriate, when biseriate, opposite to subopposite, mostly solitary or contiguous, oval to circular 10 to 20 μm in diameter, aperturate circular 4—6 μm, rarely uniseriate pits present on tangential walls of tracheids, uniseriate 8—14 μm in diameter, cross-field pits 2—3 small, oval circular, cuppressoid having oblique aperture.

Syntype — B. S. I. P., Slide No. 35855.

Locality — Godepalli, Gangapur Formation, Pranhita-Godavari Graben, Adilabad District.

Age — Lower Cretaceous.

Remarks — A few wood specimens collected from Yamanpalli have also been identified as *Podocarpoxylon* sp. (Text-figs. 3D, E) but they could not be assigned definitively to *P. parthasarthyi* due to inadequate characters. Also it has been marked that their representation in this locality is poor. Fossil woods showing anatomical characters of the family *Podocarpaceae* have been usually described under three generic names viz. *Podocarpoxylon, Phyllocladoxylon* and *Mesembrioxylon* (GOTHAN 1905). Since these genera are based upon variable characters, all the fossil woods showing features of *Podocarpaceae* should be described under the generic name *Podocarpoxylon* GOTHAN (BANDE et al. 1984) as against *Phyllocladoxylon*

GOTHAN, *Circoporoxylon* KRÄUSEL and *Mesembrioxylon* SEWARD. LAKHANPAL et al. (1975) opined that the species of *Mesembrioxylon* be critically examined before changing en block all the species of *Mesembrioxylon* to *Podocarpoxylon*. So far, nine species of *Mesembrioxylon* have been known from the Mesozoic rocks of India which have been transferred by BOSE and MAHESHWARI (1974) under the genus *Podocarpoxylon*.

The present wood resembles most to *Podocarpoxylon parthasarthyi* SAHNI, 1931, described from Sriperumbudur group, in the characters of growth rings, xylem rays and pitting. However, it rarely shows biseriate xylem rays and 1—3 pits in the field whereas in *P. parthasarthyi,* usually rays unseriate, and 2—6 round bordered pits present in the field. Such variable characters are usually noted in the same piece of wood. Therefore the present wood has been identified as *Podocarpoxylon parthasarthyi* (SAHNI, 1931) BOSE and MAHESHWARI 1974.

The Indian species of *Podocarpoxylon,* described by SAHNI (1931), RAMANUJAM (1953), BHARDWAJ (1953), SURYANARAYANA (1953), can be sharply distinguished from the present wood in one or the other character. *Podocarpoxylon schmidianum* SAHNI 1931, and *P. sahnii* RAMANUJAM 1953, both reported from Tiruvakkarai, distinguish themselves in the possession of 2—100 cells high xylem rays, 1 to 3 seriate rays and single fusiform pit in the field. *P. godavarianum* SAHNI, 1931 from Bogapalmila in the Godavari Graben, can be differentiated from the present wood in the absence of growth rings, presence of resinous parenchyma. Also pits in the cross-field area are 2—6 having slit-like pore. From *P. tirumangalense* described by SURYANARAYANA (1953) form Sriperumbudur, the present wood differs in the nature of field pitting. The genus *Podocarpoxylon tiruvakkaraianum* RAMANUJAM (1953) from Tiruvakkarai differs in the bearing xylem rays 3—50 cells high, and a large single borderless pit in the field. *Podocarpoxylon indicum* BHARADWAJ, 1953 from Rajmahal hills, Bihar, though agrees with the present form in possessing growth rings but radically contrasts in the absence of rims of Sanio and xylem parenchyma. Also the genus *Podocarpoxylon rajmahalense* JAIN 1965, reported from Rajmahal hills, conspicuously contrasts from the present specimen in having Eiporen (simple, large pit), 1—2 pinoid type pitting in crossfield area.

Discussion

The floral assemblage composed of only woods make the flora of diminutive size. The abundance of woods, however, near Yamanpalli and Godepalli and there absence elsewhere in Gangapur Formation take on added significance. The conspicuous absence of other plant organs from these new localities is noteworthy. This kind of deposition where one of the plant organs is present in enormous number is indicative of a restricted microenvironmental setting. Similarly, as evidenced by palynological data, RAO et al. (1983) have deduced the paleoclimatic and environmental interpretations in and around depositional basin. In the present assemblage

representation of two genera, namely: *Araucarioxylon* and *Podocarpoxylon* has confirmed the earlier findings that conifers have been well represented in Gangapur Formation and show sporadic development. The taxa frequently met are: *Araucarioxylon, Araucarites, Araucariacites, Pagiophyllum, Podocarpoxylon, Elatocladus, Microcachryidites* and *Coniferocaulon*. Among these, *Elatocladus* the leaf, *Podocarpoxylon* the wood, and *Microcachryidites* the palynomorph belonging to family *Podocarpaceae* occur profusely in the flora. Consequently, *Podocarpaceae* appears to be the commonest family in the Mesozoic of Pranhita — Godavari Graben.

Further, the absence of cycadophytic wood also reflects an younger age to this deposit and that supports the placement of these beds under Gangapur Formation.

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INTRA-CYCLE DYNAMICS IN A MANTIS RELIGIOSA POPULATION

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Abstract

On the basis of comparative surveys carried out on laboratory and outdoor populations of *Mantis religiosa* it is established that both the duration of development and the life span differ from the optimum in Hungary. The life span is 1,5—2 months shorter than expected in optimal conditions.

Density values are correlated with the ambient temperature. Especially spring and autumn temperature anomalies affect mortality rates.

Key words: Mantis religiosa, development, wheather conditions

Introduction

There are few publications dealing with the dynamics of preying mantid populations (e. g. BALDERRAMA and MALDONADO, 1973). The main aim of the present work is to describe the population cycle of *Mantis religiosa* in outdoor and controlled conditions, taking into account some environmental correlates.

Methods and Material

The research site is a 9 ha grassland plot at Pesterzsébet (near Budapest, Hungary) with *Festucetum rupicolae* plant association. In 1972, 200 preying mantid cocoons were experimentally introduced and monitored for 17 years. In the first generation of the studied outdoor mantid population, 88% of the viable (3 days old) individuals originated from the introduced cocoons (Table I).

Table 1. Number of resident and introduced individuals in 1972

	resident	introduced	total
N.o. of cocoons	27	200	227
N.o. of hatched ind.	3494	25 244	28 738
Ind. older than 3 days	594	4 293	4 887

The exact time of hatching and the number of hatched per cocoon was established by regular checking of marked cocoons. The number of older individuals was assessed with mark-release-recapture method (SOUTHWOOD, 1978).

Bait-stick method was used to catch mantids. Baits were living insects, usually cockroaches fixed with insect pins in dorsal position on the top of a stick higher than the herb layer.

The control population was kept in laboratory in 23 °C in the first and second larval instar and in 26 °C later. 12/12 light/dark phase was used with 2000 lux light in daytime.

Results

Components of net reproductive rate

The 17 year average of hatched individuals per cocoon is 125. Since a female lays two sets of living eggs, the average clutch size is 250. 17,2% of the young larvae could reach the age of three days, from among them about 65% were females. There are six (males) or seven (females) moultings with 12 day average time span per instar (Fig. 1, 2). The average body lengths of males and females are 5,1 and 6,5 cm respectively (Table II).

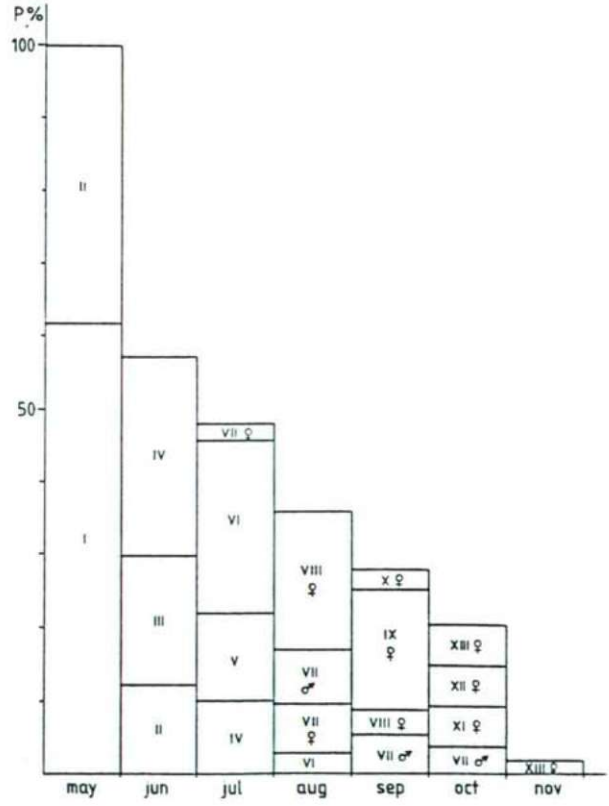

Fig. 1. 17 yr average in annual trends of the ontogenesis of preying mantid. p = frequency in percent; I—XIII developmental stages.

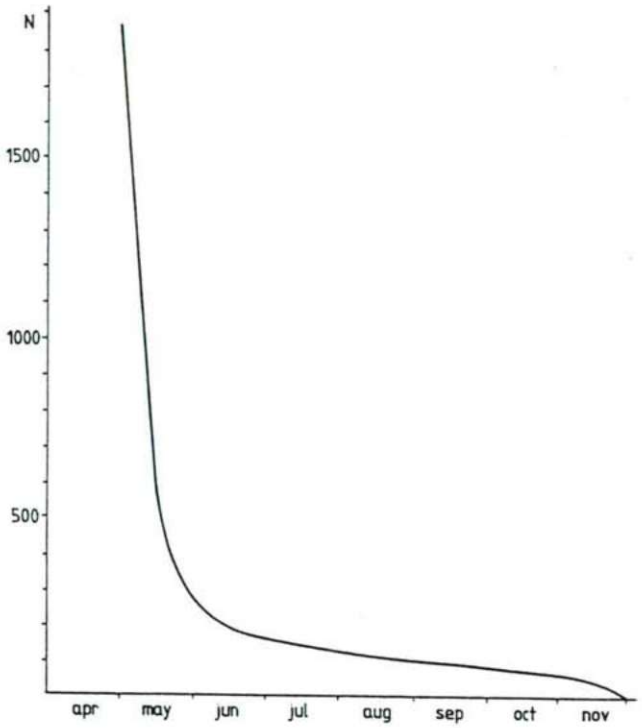

Fig. 2. Intracycle survival curve of the outdoor *Mantis* population.

Table 2. Average body size of *Mantis religiosa* in the consequtive stage of development

stage	mean body length	
after hatching	0.5 cm	
1st moulting (16 days)	0.8 cm	
2nd moulting (27 days)	1.4 cm	
3rd moulting (39 days)	2.2 cm	
4th moulting (55 days)	3.0 cm	
5th moulting (66 days)	3.9 cm	
6th moulting (75 days)	4.8 cm	(female)
6th moulting (77 days)	5.1 cm	(male)
7th moulting (86 days)	6.5 cm	(female)

In good food supply the first eggs are laid on the 11th day after the last moulting and repeating 5 times in 13 day's intervals. The two first cocoons contain viable eggs, as a rule. The average life span of females is 165 days, with a maximum of 196 days (1986). In males these figures were 110 and 176 days, respectively.

Interrelationships between ontogenesis and wheather conditions

The embryonic ontogenal stages are usually independent of climatic anomalies, because of the air compartments in the cocoons' wall, which protect against both unfavourable temperature and moisture conditions. The postembryonic developmental stages are exposed to environmetal effects as it is shown from the comparison between outdoor and laboratory populations. In captivity, under optimal environmental circumstances the average life span is 210 days (females) and 175 days (males) (Fig. 3 and 4), with 257 and 189 days' maxima.

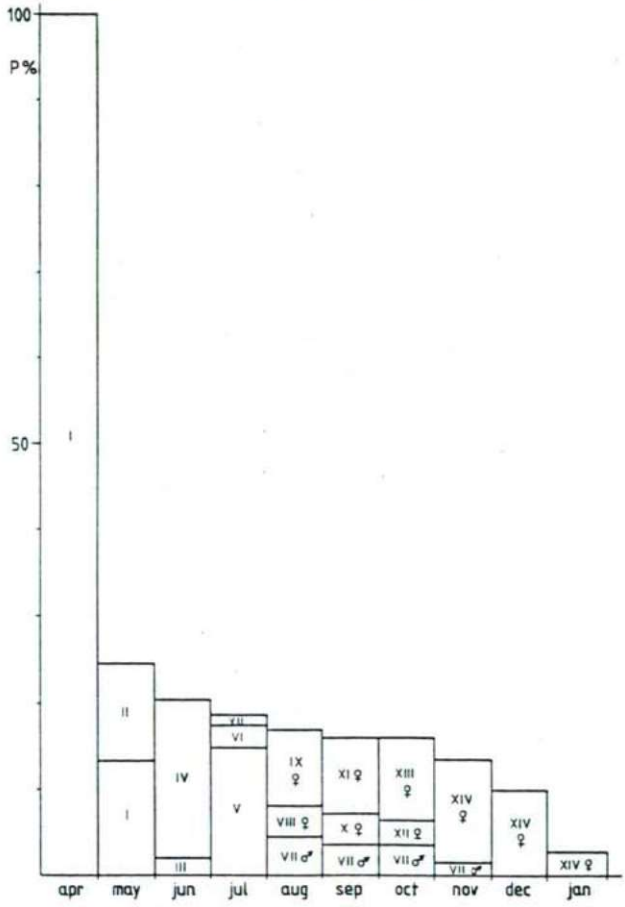

Fig. 3. Annual trends in the ontogenesis of laboratory preying mantid population.

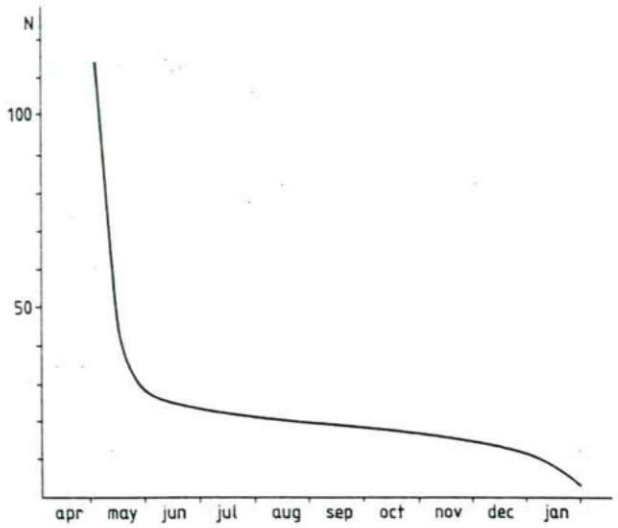

Fig. 4. Intracycle survival curve of the laboratory mantid population.

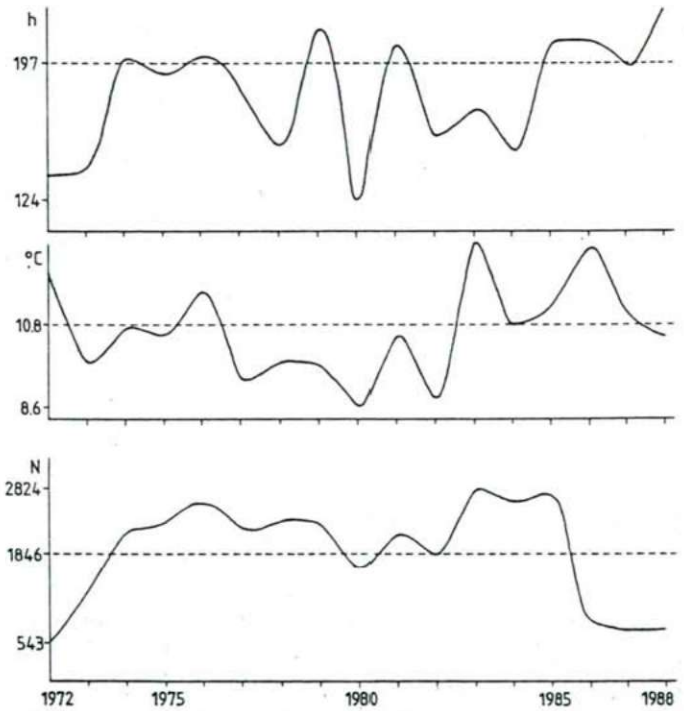

Fig. 5. Hypercyclic trends in two wheather elements (number of sunny days, h, the monthly average temperature, °C) and the number of individuals in the early stages of postembryonic developmen

In the outdoor population a significant relationship was found between temperature and survival in the postembryonic development (see Fig. 5). In the first years following introduction the population size was smaller than expected at the actual temperature. By 1976 this difference was totally compensated by the high hatching rates of cocoons. The cold wheather in April resulted in fewer surviving individuals in 1980 and 1982 when the temperature differed from the average with —2,2 and —2 °C respectively. The correlation was also clear in 1976 and in 1983 when the higher temperature (+0,9 and +2,2 °C above average) led to higher survival rates. In November the only mortality factor is the temperature. If the November average is below zero, the expectance of survival is negligable (as in 1983).

In the early and mid-summer, the temperature is a conditioning factor without causing mortality. The development is completed by the end of August, therefore mantids are not sensitive to moderately low temperatures in early autumn (see HIDEG, 1989 for details).

Discussion

It is clear from the results (low hatching rates and survival of the young larvae in April, high mortality values in November) that the climate in Hungary is suboptimal for mantids having a subtropical origin. Only 150 of the 2000 known mantid species live in temperate regions within the limits of 46 latitudes (GÜNTHER, 1968).

Several authors (e. g. BALDERRAMA and MALDONADO, 1973; GURNEY, 1950; SZALKAY, 1971) emphasized the high temperature demands and the wide tolerance limits to rainfall. These are in accordance with the results of the present paper.

Sphodromantis viridis, a Mediterranean mantid has similar environmental demands as *Mantis religiosa.* Its optimal temperature ranges between 25 and 30 °C. The lower developmental threshold is 17 °C and the temperature above 35 °C is also disadvantageous (KÖNIGSMANN 1963). Some mantids are inactive in mid-day to avoid high temperature (e. g. *Eremiaphila* spp., see GÜNTER, 1968).

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DROUGHT—INDUCED CHANGES IN A SANDY GRASSLAND COMPLEX IN THE GREAT HUNGARIAN PLAIN

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Abstract

Changes in floristic composition, which were induced by precipitation pattern, were detected in the sandy grassland communities existing in varied relief. The averages of characteristic indicator values W of three associations, such as the *Festucetum vaginatae, Potentillo-Festucetum pseudovinae* and *Molinio-Salicetum rosmarinifoliae,* were different which also reflected in the character, speed and intensity of their response to the fluctuations of precipitation pattern. The successive alteration of W-average was the most intense in the case of mesic grassland, and slight in dry grasslands. It had not any trend in *Festucetum vaginatae.*

The most pronounced changes in physiognomy appeared with the *Milinio-Salicetum rosmarinifoliae,* while that of the communities of extremely dry sand hills was only slight.

Key words: climatic changes, fluctuation, ordination, secondary succession, water supply

Introduction

Structural changes within a community are governed by environmental factors, life cycles of constituent populations, and their interference patterns. The effect of physiographic processes was studied for instance by OLSON (1958) and TAMURA et al. (1986) and that of climatic changes by ORR and EVENSON (1986), ROSEN (1985) and ROUNDY (1985). The examination of biotic processes included regeneration fluctuations of populations (BARCLAY-ESTRUP, 1970; BILLINGS and MARK, 1961; COUPLAND, 1974; WATT, 1947), competitive interactions (MULLER, 1974; CLATWORTHY, 1960; DE WIT, 1960), changes in biomass structure (SYMONIDES and BOROWIECKA, 1985), the impact of herbivores (BROWN, 1982; MURDOCH et al., 1972; STINSON and BROWN, 1983; WATT, 1981) or human interference (e.g., HOKKANEN and RAATIKAINEN, 1977; LINDHOLM and NUMMELIN, 1983; ROSEN, 1984).

Some of the factors influencing the vegetation dynamics involve heavy damage (e.g., human effect, intensive grazing), which lead to quick structural change, and induce very diverse successional pathways depending on intensity of the disturbance and on the presence of propagules of colonizing populations. Irregularities in climatic parameters may also cause quick changes in vegetation structure, when they have extreme values for a long time. These, however, do not induce new successional pathways, but rather accelerate the natural ones, or cause fluctuations or retrogressive developments in vegetation pattern.

The effect of precipitation (and its spatial and temporal distribution) is of great importance especially in xerothermic circumstances (HARPER, 1977), where the water supply is one of the limiting factors. Long precipitation-poor periods developing (sometimes lasting several years) may cause quick and serious structural change. In this paper an effect of such periods in a sandy grassland complex was studied. Particular attention was focused to the quality and speed of the structural change with respect to different plant communities.

Material and Methods

Investigations were carried out in the Kiskunság National Park (Hungary) between 1981 and 1988. The experimental area was a 2.4 ha portion of a sandy pasture. This area was free of grazing since 1976, but earlier it was grazed moderately by cattle. Varied relief with the maximum elevation differences of about 3 m, supports four characteristic associations; three sandy grassland communities (the *Brometum tectorum, Festucetum vaginatae,* and *Potentillo-Festucetum pseudovinae),* and a mesic dune-slack community of the *Molinio-Salicetum rosmarinifoliae* (nomenclature after SOÓ, 1964.) A more detailed description of the communities and the characteristics of the habitats are given by KÖRMÖCZI et al. (1981) and KÖRMÖCZI (1983).

The phytosociologic relevés were derived from 13 permanent plots of representative stands. The number of plots per community was proportional to the total area covered by them. *(Festucetum vaginatae:* 3 plots; *Potentillo-Festucetum pseudovinae:* 7 plots; Molinio-Salicetum rosmarinifoliae: 3 plots.) Thus no records were made in the *Brometum tectorum* because of its very small area.

The relevés were recorded from 2 × 2 m quadrats; relative cover values of the species in the relevé plot were scored in a late spring period (end of May until beginning of June) in each studied year in order to eliminate effect of seasonal fluctuations in vegetation.

Multivariate statistical analyses were used to evaluate the collected data. Cluster analysis was based on Euclidean distance and group average linkage algorithm (PODANI, 1980). Principal component analysis (PCA) based on correlation coefficient was also used (PIELOU, 1984). The 13 plots were divided into three groups (associations) on the basis of the cluster analisys of 1981-relevés.

For characterizing the changes of vegetation I used the TWR indicator values developed by ZÓLYOMI et al. (1967) that refer to temperature (T), water (W) and soil acidity (R) demand of species. Averages of these indicator values were calculated for particular years weighting by proportional coverage of species.

The actual climadiagram of the studied years was constructed on the basis of data from Kecskemét Meteorological Station. The monthly mean temperature and amount of precipitation in 1977—1988 were plotted.

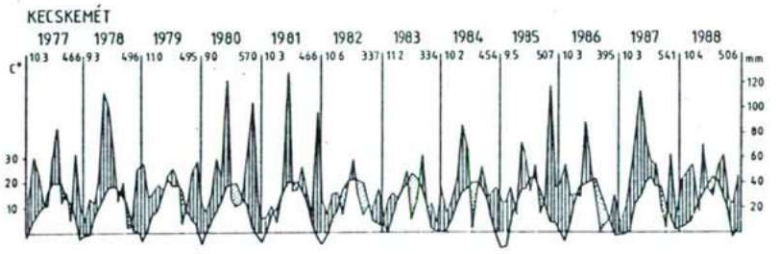

Fig. 1. Walter-Lieth diagramme of climate of the studied years based on data from the Kecskemét Meteorological Station

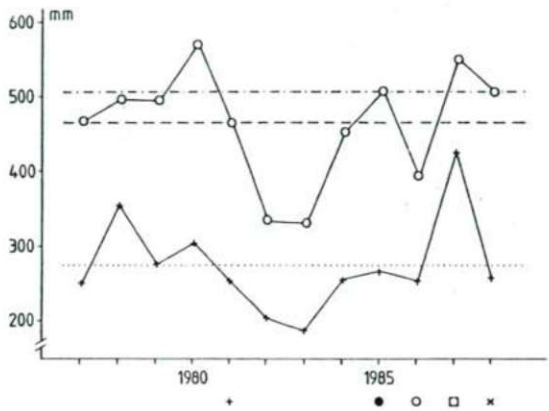

Fig. 2. Annual precipitation sum (o) and average (— — —) for the years 1977—1988 and 50-year average (— . —) in mm, and precipitation sum March-August (+) for years in question and average (...). Signs indicating the sampling years (1981: + ;1985:○:1986:●;1987:□;1988:x) are used in Fig. 3. and 4.

The mesoclimate pattern of the experimental area between 1977 and 1988 is shown in Figure 1. The climate of the Kiskunság region (Great Hungarian Plain) is semiarid-continental, the average annual precipitation is about 500 mm, and the annual mean temperature is 10.3 C. The climate of the early period of the examination term was similar to the many-year average. But according to the Figure 1 the precipitation was very low during the period beginning in 1982 and especially in 1982—1984, which is shown markedly by drought periods in summer. Figure 2 presents data on annual rainfall and summer rainfall from March—August and clearly shows the 1982—1984 period with a precipitation deficit, but the summers were dryer than average from 1981 to 1986. The decrease in the average of 12-year annual precipitation compared with the 50-year average included a lack of important winter precipitation. This very unpleasant climatic effect imposed such a strong stress on vegetation, that it became a controlling factor of vegetation changes.

Results

Tables 1—3. show the summary of phytosociological relevés from experimental years. Species presences, life forms (Soó, 1980) and indicator values (Zólyomi, 1967) are presented.

The studied associations, altough supported by different habitats, show many common features. Their species number per sample is low, which also can be ascribed to small size of the sampling plots. As compared with the 126 species occurring in the whole experimental area (Gallé et al., 1985) the average number of species per plot varied between 7—17. The total number of species in a community was, however, considerably high. The average species number in the *Festucetum vaginatae* samples varied between 7—13, but the cumulative species number (all species in all samples of the association) was 11—24 in the spring season and during a particular

Table 1. Summary of phytosociological relevés from the experimental years for *Festucetum-vaginatae* association. Life forms, presences and indicator values of species are presented. Also the weighted averages of indicator values for particular years are given.

	life forms	presence					indicator values		
		1981	1985	1986	1987	1988	T	W	R
Onosma arenaria	H	+					6	2	4
Leontodon autumnalis	H	+	+	+			5	6	0
Carex stenophylla	G	+	+	+	+	+	5	1	4
Eryngium campestre	H	+	+	+	+	+	7	2	4
Euphorbia segueriana	H	+	+	+	+	+	6	1	4
Festuca pseudovina	H	+	+	+	+	+	5	2	0
Festuca vaginata	H	+	+	+	+	+	6	0	5
Potentilla arenaria	H	+	+	+	+	+	6	1	5
Medicago minima	Th	+	+	+		+	7	2	4
Cynodon dactylon	G(H)	+		+	+	+	6	3	0
Secale silvestris	Th	+		+	+		5	0	5
Cerastium semidecandrum	Th		+				6	3	0
Myosotis arvensis	TH		+				5	3	0
Arenaria serpyllifolia	Th		+	+	+		5	1	3
Bromus squarrosus	Th		+	+	+		7	2	4
Achillea millefolium	H		+	+	+	+	5	3	0
Galium verum	H		+	+	+	+	5	3	4
Koeleria glauca	H		+	+	+	+	5	1	0
Silene otites	H		+	+	+	+	5	2	4
Thymus degenianus	Ch		+	+	+	+	-	-	-
Carex liparocarpos	G		+		+		6	3	4
Poa bulbosa	H		+		+	+	6	2	4
Polygonum arenarium	Th			+			6	0	0
Silene conica	Th			+			6	1	4
Calamagrostis epigeios	H-G			+			5	1	4
Minuartia glomerata	Th			+			5	2	5
Minuartia verna	H-Ch			+	+		4	2	4
Dianthus pontederae	H			+	+	+	6	2	4
Tragopogon dubius	TH			+	+	+	6	4	0
Kochia laniflora	Th			+	+	+	5	1	0
Teucrium chamaerdys	Ch				+		6	2	4
Poa angustifolia	H				+		5	3	4
Stipa capillata	H					+	6	2	4
T average		5.85	5.66	5.57	5.52	5.60			
W average		1.78	1.68	1.92	1.88	1.93			
R average		4.74	4.51	4.55	4.62	4.64			
species number		11	19	24	23	17			

Table 2. Summary of phytosociological relevés from the experimental years for *Potentillo-Festucetum pseudovinae* association. (For legend see Table 1)

	life forms	presence					indicator values		
		1981	1985	1986	1987	1988	T	W	R
Bromus tectorum	Th	+					7	2	0
Molinia coerulea	H	+	+				5	7	0
Plantago lanceolata	H	+	+	+	+		5	4	0
Tragopogon dubius	TH	+		+		+	6	4	0
Achillea millefolium	H	+	+	+	+	+	5	3	0
Carex stenophylla	G	+	+	+	+	+	5	1	4
Dianthus pontederae	H	+	+	+	+	+	6	2	4
Eryngium campestre	H	+	+	+	+	+	7	2	4
Euphorbia segueriana	H	+	+	+	+	+	6	1	4
Festuca pseudovina	H	+	+	+	+	+	5	2	0
Galium verum	H	+	+	+	+	+	5	3	4
Potentilla arenaria	H	+	+	+	+	+	6	1	5
Thymus degenianus	Ch	+	+	+	+	+	—	—	—
Veronica prostrata	Ch	+	+		+		6	2	4
Cynodon dactylon	G(H)	+		+	+	+	6	3	0
Holoschoenus vulgaris	G	+		+	+	+	6	6	4
Ononis spinosa	H-Ch	+		+	+	+	5	3	0
Arenaria serpyllifolia	Th		+				5	1	3
Cerastium semdecandrum	Th		+				6	3	0
Taraxacum officinale	H		+				0	5	0
Leontodon autumnalis	H		+	+			5	6	0
Medicago minima	Th		+			+	7	2	4
Euphorbia cyparissias	H(G)		+	+	+	+	5	3	0
Falcaria vulgaris	Th-TH		+	+	+	+	7	2	4
Festuca vaginata	H		+	+	+	+	6	0	5
Koeleria glauca	H		+	+	+	+	5	1	0
Silene otites	H		+	+	+	+	5	2	4
Stipa capillata	H		+	+	+	+	6	1	4
Trifolium montanum	H		+	+	+	+	5	3	4
Colchicum arenarium	G		+		+		7	2	4
Poa bulbosa	H		+		+		6	2	4
Anchusa officinalis	TH-H			+			6	3	0
Equisetum ramosissimum	G			+			0	2	0
Silene conica	Th			+			6	1	4
Phleum pratense	H			+	+		5	5	0
Poa angustifolia	H			+	+		5	3	4
Scabiosa ochroleuca	H			+		+	6	2	4
Erysimum diffusum	TH—H	+			+	+	5	2	4
Calamagrostis epigeios	H-G			+	+	+	5	3	0
Teucrium chamaedrys	Ch			+	+	+	6	2	4
Carex liparocarpos	G				+		6	3	4

Table 2. (cont.)

	life forms	presence					indicator values		
		1981	1985	1986	1987	1988	T	W	R
Alkanna tinctoria	H				+		7	0	5
Marrubium peregrinum	H-Ch				+		7	3	0
Minuartia verna	H-Ch				+		4	2	4
Myosotis stricta	Th				+		5	2	0
Secale silvestris	Th				+		5	0	5
Verbascum phoeniceum	H				+		6	2	4
Veronica spicata	H-Ch				+		5	1	4
Hieracium auriculoides	H				+	+	5	5	3
Medicago falcata	H				+	+	6	3	4
Dianthus serotinus	H					+	6	0	5
Onosma arenaria	H					+	6	2	4
Poa bulbosa	H					+	6	2	4
Rhinanthus borbási	Th					+	—	—	—
Trinia ramosissima	H					+	6	4	4
T average		5.43	5.39	5.56	5.40	5.47			
W average		2.07	2.12	2.05	1.93	1.97			
R average		4.38	4.14	4.14	4.10	4.14			
species number		17	25	30	38	32			

Table 3. Summary of phytosociological relevés from the experimental years for *Molinio-Salicetum rosmarinifoliae* association. (For legend see Table 1)

	life forms	presence					indicator values		
		1981	1985	1986	1987	1988	T	W	R
Leontodon autumnalis	H	+			+		5	6	0
Cynodon dactylon	G(H)	+				+	6	3	0
Molinia coerulea	H	+	+			+	5	7	0
Achillea millefolium	H	+	+	+	+	+	5	3	0
Galium verum	H	+	+	+	+	+	5	3	4
Holoschoenus vulgaris	G	+	+	+	+	+	6	6	4
Ononis spinosa	H-Ch	+	+	+	+	+	5	3	0
Plantago lanceolata	H	+	+	+	+	+	5	4	0
Poa angustfolia	H	+	+	+	+	+	5	3	4
Potentilla arenaria	H	+	+	+	+	+	6	1	5
Salix rosarinifolia	M		+				5	1	3
Schoenus nigricans	HH	+	+	+	+	+	5	9	5
Polygala comosa	H-Ch	+	+	+	+	+	5	1	4
Arenaria serpyllifolia	Th		+				5	1	3
Cerastium semidecandrum	Th		+				6	3	0
Senecio vernalis	Th-TH		+				—	—	—
Centaurea pannonica	H		+		+		5	6	0
Veronica prostrata	Ch		+		+		6	2	4
Calamagrostis epigeios	H-G		+	+	+	+	5	3	0
Euphorbia cyparissias	H(G)		+	+	+	+	5	3	0
Euphorbia segueriana	H		+	+	+	+	6	1	4
Silene otites	H		+	+	+	+	5	4	2
Thymus degenianus	Ch		+	+	+	+	—	—	—
Koeleria glauca	H		+		+	+	5	1	0
Equisetum ramosissimum	G			+			0	2	0
Medicago minima	Th			+			7	2	4
Myosotis stricta	Th			+			5	2	0
Potentilla reptans	H			+			6	0	3
Tragopogon dubius	TH			+			5	1	4
Verbascum lycnitis	TH			+	+		5	1	4
Eryngium campestre	H			+		+	7	2	4
Carex liparocarpos	G			+	+	+	6	3	4
Carex stenophylla	G			+	+	+	5	1	4
Festuca pseudovina	H			+	+	+	5	2	0
Scabiosa ochroleuca	H			+	+	+	6	2	4
Teucrium chamaedrys	Ch			+	+	+	6	2	4
Minuartia glomerata	Th				+		5	2	5
Poa bulbosa	H				+		6	2	4
Veronica praecox	Th				+		6	2	3

Table 3. (cont.)

	life forms	presence					indicator values		
		1981	1985	1986	1987	1988	T	W	R
Dianthus pontederae	H				+	+	6	2	4
Erysimum diffusum	TH-H				+	+	5	2	4
Hieracium auriculoides	H				+	+	5	5	3
Trinia ramosissima	H				+	+	6	4	4
Viola arvensis	Th				+	+	5	4	0
Plantago maritima	H				+	+	5	6	5
Rhinanthus borbási	Th					+	—	—	—
Seseli annuum	Th-TH					+	6	4	1
T average		5.11	5.07	5.30	5.22	5.31			
W average		4.17	4.30	3.16	3.35	3.58			
R average		4.05	4.13	4.15	4.02	3.98			
species number		14	21	26	33	33			

year amounted to 45. For the *Potentillo-Festucetum pseudovinae* the average species number was between 17—38, while those of the *Molinio-Salicetum rosmarinifoliae* between 7—17 and 14—33, respectively. The low species number per sample and high number of species in a community reflect a spatial variability of the experimental area.

An important feature of changes is that the number of species in each community increased in the course of experimental years, but in the case of xeric associations, especially in *Festucetum vaginatae,* some decrease was observed is the last year.

Since the associations in question were recognized and studied before the fencing of the experimental area (BODROGKÖZY and FARKAS, 1981; KÖRMÖCZI et al., 1981) and since this part of pasture field had been moderately grazed (but only until 1976), it was possible that the species changes between 1981 and 1988 were caused primarily not by the exclosure of animals but by drought period. It is supported well by the changes of average value of W, while those of T and R didn't show any trend (see tables 1—3). (The W-averages differ in the three associations from each other, but it reflects to microclimatic effects of secondary importance in this case — KÖRMÖCZI et al., 1981.)

The marked alterations occurred in *Molinio-Salicetum rosmarinifoliae,* i.e. the greatest decrease of average water demand can be detected in this case. The W-values of disappearing species were higher than those of appearing ones. The W-average of species disappearing until 1987 is 4.33, while that of entering species is 2.13. This trend can be seen in case of *Potentillo-Fesucetum pseudovinae,* as well, though the W-average decreased less.

In the association of extreme dry sites (*Festucetum vaginatae*) the changes of average water demand couldn't be detected, but the species number increased (Table 1) similarly to the other two associations.

It can be mentioned, however, that only few species disappeared from the set of the first year in case of either communities but the proportions of cover changes considerably, and the appearing species were partly annuals, and partly perennials with smaller water demand (Tables 1—3).

Discussion

One of the most important background factors in the development of structure of a sandy grassland is water supply (FEKETE et al., 1979; KOVÁCS-LÁNG, 1974; HOKKANEN and RAATIKAINEN, 1977). The biotic communities in these habitats are affected by the climate to a different degree, and with different biotic communities different elements of the climate can be considered as controlling (GYÖRFFY and KÖRMÖCZI, 1987 a; b).

Water is a direct limiting factor for the vegetation. The amount of precipitation in vegetation periods is of primary importance, while the deviations in monthly mean temperature, monthly maximum and minimum temperature from the many-year average were not considerable. It became clear that the monthly precipitation fluctuations might have played an important role in generating the structural changes in vegetation (VAN DER MAAREL, 1981).

In the course of the last 12 years, 1982 was a marking point characteristic by its very high precipitation deficit, which lasted for three years, and only in winter of 1985 was there a larger water supply available (Fig. 1). Also the subsequent yeras

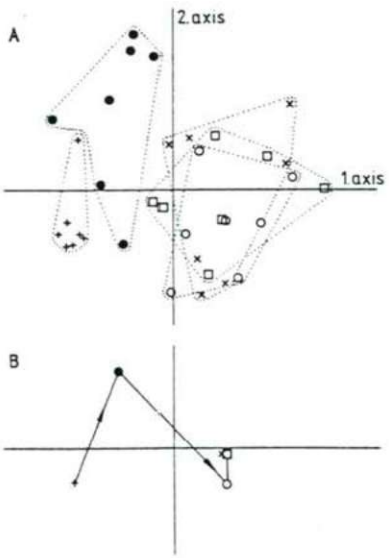

Fig. 3. The PCA of revelés made in different years in *Potentillo-Festucetum pseudovinae* association (A). Trajectories of the centres of revelés belonging to the same year (B). For legend see Fig. 2.

were rather precipitation-poor (below the average; especially in the vegetation period). The response of the studied communities manifested in appearance of some new colonizing species and in alteration of cover proportions. The new colonizer species were rather annuals or perennials with smaller water demand.

The changes within the studied plant communities were following different pathways. They were uniformly within the *Potentillo-Festucetum pseudovinae*. In terms of the ordination results the shifts of objects were mainly synchronous. The points belonging to the same year remained together, and considerable structural changes could not be detected in the last three years. Figure 3B shows the trajectories of the centres of objects belonging to the same year. The strongest correlation to the average W-values can be detected with the frist component scores.

I could not find a close correlation between W-average of assocations and sum of annual precipitation. It was negative in the case of *Potentillo-Festucetum pseudovinae,* but positive (but very weak: $r = 0.28$) when was calculated with the precipitation of previous years. The correlation was, however, stronger ($r = 0.62$) between the

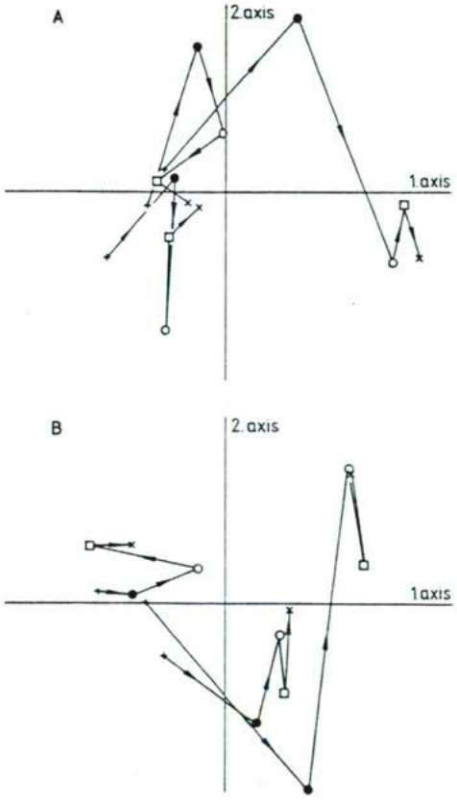

Fig. 4. The PCA of revelés made in different years in permanent plots of the studied associations. A. *Festucetum vaginatae,* B. *Molinio-Salicetum rosmarinifoliae.* For legend see Fig. 2.

decrease of W-average and time. The situation is similar with *Molinio-Salicetum rosmarinifoliae,* but it had also a weak positive correlation (r = 0.24) between W-average and precipitation of actual years. Its correlation with time was 0.65.

Two stands of *Festucetum vaginatae* association show narrow range along the frist axis but the movement (the trajectories) of the third one is similar to that of *Potentillo-Festcetum pseudovinae* (Fig. 4A). In the cluster analysis these three stands formed a tight cluster but later the character of one of them proved to be similar to that of *Potentillo-Festucetum pseudovinae.* The communities of the other two sites were in extreme dry conditions from the earliest recording, that is why they were hardly influenced by drought.

There is a similar situation with *Molinio-Salicetum rosmarinifoliae.* Also the three stands showed a tight cluster for the first experimental year, but later they diverged, two stands showed the change depending on the water deficit (there is a strong correlation between the first component scores and average W-values for the particular years, too). The small fluctuation of the third stand is the result of its topografic position. It is situated in the deepest wind groove, the water conditions of which were the most favourable, and as a consequence of this the above mentioned community could tolerate the precipitation deficiency here.

The correlation between W-average and time and between W-average and lst PCA axis scores reflects to the temporal change of water condition of the studied associations. But it does not support the direct connection between structural changes and precipitation. Maybe, the effect of precipitation deficit is manifested by the decrease of water table, or it is superposed on water table decrease. (The average water table was about 70 cm under the soil surface in 1978 at the deepest point of the study area, but it was under 3.0 m in 1986. KÖRMÖCZI ined.)

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TEMPORAL AND SPATIAL PATTERN OF A DIPLOPOD POPULATION (MEGAPHYLLUM UNILINEATUM (C. L. KOCH)) IN A SANDY GRASSLAND

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Abstract

The complex ecological studies (started in 1976) in a sandy grassland of Kiskunság National Park (Hungary) have given a good oppotunity to analyse the population characteristics of *Megaphyllum unilineatum* (C. L. KOCH), the only diplopod species living in that site.

Based on three years data sets of pitfall trapping (1983—85) the population's seasonal changes and spatial distribution were analysed on the basis of their surface activity. It can be concluded that

(1) the seasonal activity curve of the population has three peaks (spring, early summer and autumn). These peaks are related to climatic changes and reproductive periods.

(2) The spatial distribution is aggregated as a consequence of the heterogeneous habitat, macro-and microclimatic conditions. The places of aggregation are in so called shelter sites.

(3) The early larval stages appear at certain sites with most equalized microclimate („shelters").

Key words: Diplopoda, Iulidae, *Megaphyllum unilineatum*, sandy grassland, spatial heterogeneity, seasonal changes, population dynamics, clumped dispersion

Introduction

Most publications on diplopods deal with species of woody habitats. Studies on the fauna of different grassland types are very rare (HAACKER, 1968; COTTON and MILLER, 1974; BAKER, 1978a,b; BERCOVITZ and WARBURG, 1985; MEYER, 1985). The main reason for this fact may be due to the low species diversity of diplopods in such habitats. The studied *Megaphyllum unilineatum* is a drought resistent species of Mediterranean origin (GOLOVATCH, 1990), widely distributed in the Hungarian fauna. It is common in dry grasslands, in open acacia and poplar forests in Hungary. The species characteristics, environmental needs, areal distribution is given by HAACKER (1968).

Materials and methods

Description of site

Our ecological studies were carried out in a typical sandy grassland of the Great Plains, in central Hungary (Kiskunság National Park, Bugac region (MÓCZÁR et al., 1980). The investigated area is a part (2.4 ha, isolated of grazing by a fence) of a large pasture, the so called Puszta. The surface of the study

site is heteromorph, dissected by wind-formed grooves and sand ridges, what means level differences of 2.5—3 m. The plant cover of the area stays mainly in three, mosaic-like plant assotiations (Fig. 1.), growing as a result of a secondary succession caused by the mentioned isolation (lack of grazing).

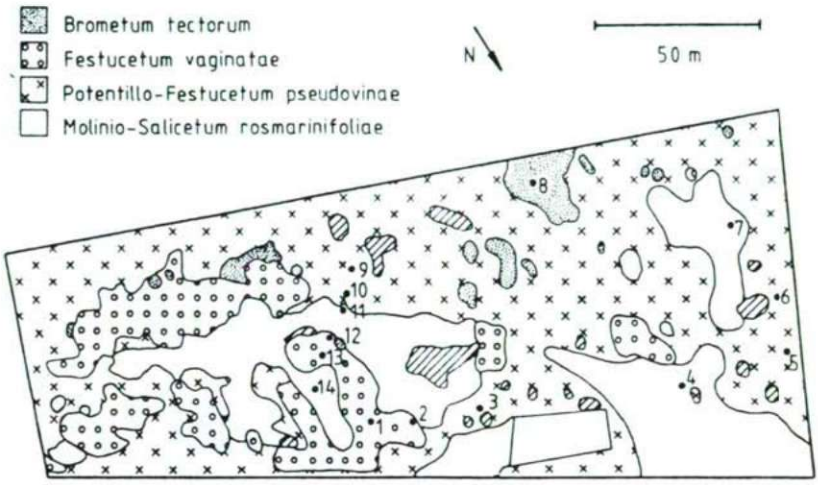

Fig. 1. Map of the investigated area with the different plant associations. The numbers (1—14) indicate the sites of trapgroups.

On higher levels (sand ridges) an open, perennial sandy-steppe grass assotiation (*Festucetum vaginatae* (FV)) can be found. The coverage of plants is low (40—60%), with large patches of bare sand surface. The soil here is coarse grained, having low humus (under 1.5%) and moisture content (between 2 and 7%). On deeper stands (wind grooves) appears a more dense association of *Molinio-Salicaetum rosmarinifoliae* (MSR), which consists of higher plants, means a closed grass association (total coverage 85—100%). The soil moisture here is 3—14% and the humus content is about 3.5% (KÖRMÖCZI, 1983).

The macroclimate is semiarid with a summer precipitation under 200 mm and with a daily temperature fluctuation of 27—32 °C. (Detailed description of this area can be found in BODROGKÖZY and FARKAS, 1981; KÖRMÖCZI et al., 1981; KÖRMÖCZI, 1983; HORNUNG, 1984.)

Sample methods

Nearly 6000 specimens of *M. unilineatum* were collected by pitfall-trapping from 14 standard sites of the area (Fig. 1.) through three years, from 1983 to 1985. The traps were emptied bi-weekly during the whole activity period, from March till the end of November. (For detailed sampling technique see HORNUNG, 1984.) The continuous data sets give a good possibility to study the population both in time and space. Thus we gain information about the relative abundance and locomotion activity of individuals.

Evaluation

Population dynamics was followed on the basis of trapped individuals' mean numbers at the regular sampling periods.

To introduce spatial heterogeneity dispersion was analysed. The pitfall traps were placed at 14 standard sites of the three main plant associations: in *Festucetum vaginatae* (FV) on sand ridges (trap No. 1, 2, 10, 12, 13), *Potentillo-Festucetum pseudovinae* (PFP) (No. 3, 5, 6, 9) and *Molinio-Salicaetum rosmarinifoliae* (MSR) in wind grooves (No. 4, 7. 11, 14). Trap No. 8 — by its environmental characteristics — can be envolved in FV trapgroup.

Type of dispersion was analysed: Index of dispersion ($I_D = s^2/\bar{x}$, in sensu SOUTHWOOD, 1978) was calculated for every sampling period of each year (Fig. 2.).

Group average clustering of Chekanovski's similarity coefficient was used for comparision of habitat patches (see SOUTHWOOD, 1978).

Results and discussion

Population dynamics

The curves of population changes show the same seasonal tendency during the three years studied (Fig. 2.). They have three maxima: in April, in June and in October. Activity with three peaks was shown by David (1984). MEYER (1985) found julid species with one and two peaks of abundance, whereas PEITSALMI (1981), DUNGER and STEINMETZGER (1981) described two activity peaks. The differences may be due to either the great geographic distances, or to both the different species and their different environments within their habitats.

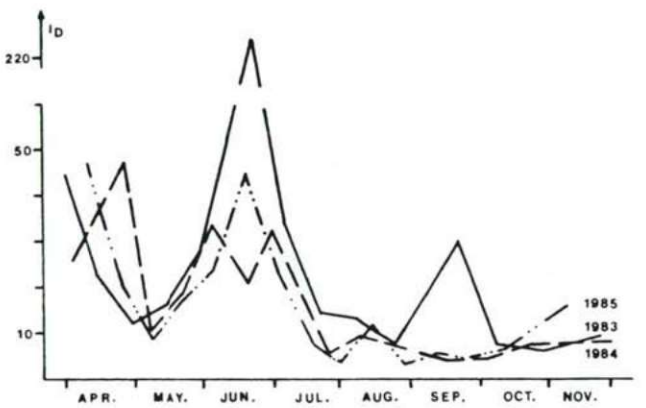

Fig. 2. The changes of dispersion indices (I_D) during the investigated time periods.

For standardization values of Fig. 3. (number of caught individuals) are corrected for trapdays. The first peak appears in spring, when climatic conditions are relatively favourable and individuals are surface active. During this time a large number of individuals can be observed moving on the bare sand, too.

The decreased number during May, after the first peak can be due to the partial inactivity of ovipositing females. The sex rate of adults is about or above 0.5 in this period (Fig. 3.). All the authors calculating sex rate found that number of females exceed that or males. (For further data see HALKKA (1958) and TRACZ (1984).)

In June (second peak) the females after having layed their eggs, may become active again and also the first moving larval stage (second developmental stage with one ocellus) appears.

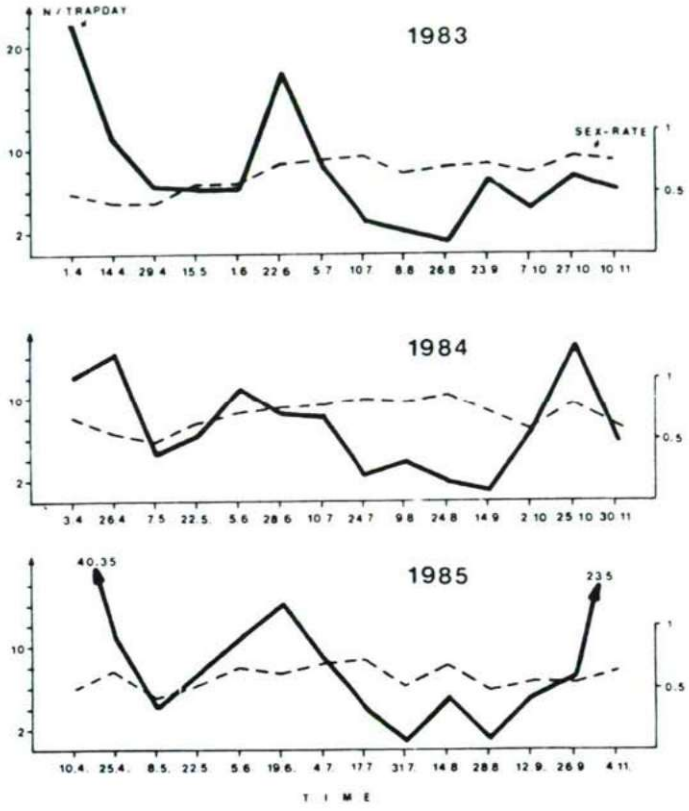

Fig. 3. The changes in the number of trapped individuals, corrected for trap-days.

The great decline in mid-summer must be due to weather conditions as drought prevails during this period. As a result soil surface temperature reaches a maximum and soil moisture content is at a minimum. Under such extreme physical conditions individuals may become totally inactive. This is called „summer-sleep" by STOJALOWSKA (1961).

The third peak in activity appears in October. With improving climatic conditions the surface activity increases. Mating pairs can be regularly found during the fall.

Spatial heterogeneity

On the basis of dispersion indices the distribution of the population prooved to be aggregated during all periods (Fig. 2.). The highest aggregation was noticed in April and in June during all three years. Dispersion indices are significant in every

case ($p<0.001$) by the chi-square test. Fig. 4/a. shows the dendrograms of similarity of sites based on the the 14 trap-sites and the different sampling periods. It can be clearly seen that diplopods qualify their habitat to be „coarse grained". The traps are divided into two similarity groups. The „most favourable" sites are shown by the three-dimensional figure of trapped individuals (Fig. 4/b.) where the number of

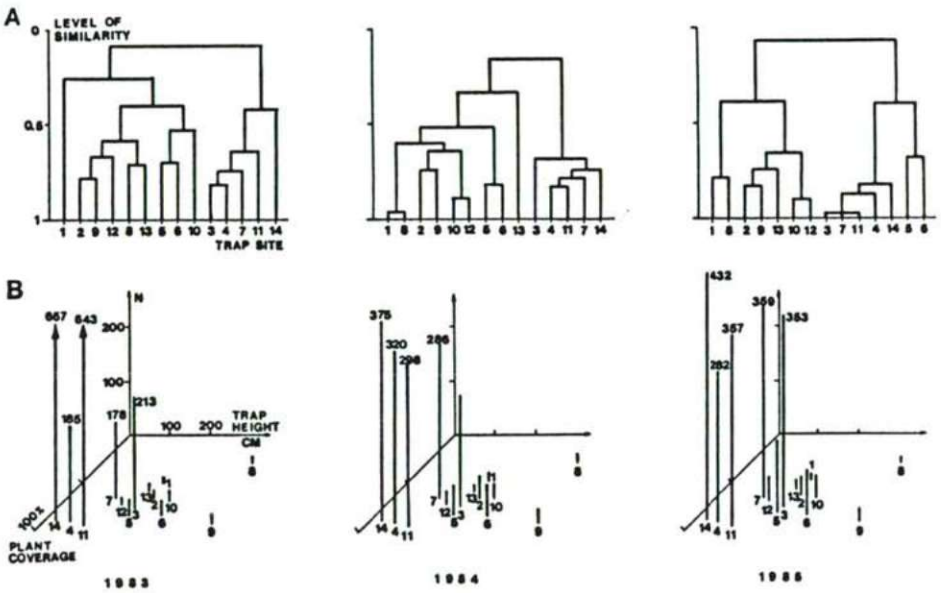

Fig. 4/a. Dendrograms of similarity of the 14 trap sites (Chekanowski's coefficient; group averaging).
4/b. Number of trapped animals during the different years in connection with plant coverage and the vertical position of traps.

diplopods is related to the vertical position of sampling sites („trap height") and to the percentage of plant coverage. The highest figures are the ones in „wind groove" traps. Diplopods seem to prefer living at deeper places, with high plant coverage (Trap No. 4, 7, 11, 14). These sites were located in the MSR association, where relative humidity was the highest within the study area (35—48% during summer midday). The daily temperature fluctuations were lower comparing to sand ridges. The soil surface temperature fluctuated less because of increased foliage heights (40—60 cm) and denser plant cover (85—100%). These were the sites most frequently used

for egg laying. More than 90% of the early larval stages (mainly the second) appear in wind groove traps. They are the most sensitive to humidity. Early instars are known to assamble in the hatching site (STRIGANOVA and MAZANTSEVA, 1979). Egg clutches can be often found under these traps. Survival probability of larvae is the highest at these humid places (see also HALKKA, 1958; PEITSALMI, 1981). These microhabitats are the sites of adult aggregation aswell. About 70% of adults were trapped there.

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DER EINFLUSS VON KONSANGUINTÄT UND ENDOGAMIE IM BEREICH MORPHOLOGISCHER MERKMALE

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Zusammenfassung

Das Material wurde aus drei Dörfern mit Bevölkerung gleicher Abstammung gesammelt. Zwei dieser Dörfer befinden sich in unmittelbarer Nähe und stehen in engen Heiratsbeziehungen zueinander. Das dritte und kleinste Dorf liegt ziemlich weit entfernt und bildet ein selbständiges Isolat, das einen signifikant höheren Inzuchtkoeffizient und Endogamieindex im Vergleich zu den anderen beiden aufweist.

Es wurden 40 Kopf- und Körpermasse sowie die entsprechenden Indices untersucht. Unterschiede zwischen den Kopf-Gesichts-Merkmalen gibt es wenige und nur schwach signifikante. Was die Körpermerkmale betrifft, unterscheiden sich die Frauen aus dem kleineren, stark endogamen Dorf hochsignifikant von den Frauen der beiden anderen Dörfer. Die Körperhöhen und Sitzhöhen sind kleiner, dafür alle anderen Merkmale wesentlich grösser. Bei den Männern erscheinen ähnliche Tendenzen nur für Körperhöhe, Sitzhöhe und relative Schulterbreite.

Schlüsselwörter: Endogamie, Konsanguinität, Isolate, Körpermasse, Inzuchtkoeffizient.

Einführung

Wir kennen heute zahlreiche Arbeiten, die sich mit dem Effekt von EXO- und Endogamie im Bereich der anthropometrischen Daten beschäftigen (HULSE, 1958; WOLANSKI et al., 1970; SCHULL und NEEL, 1965; SCHREIDER, 1967; FERAK und LICHARDOVA, 1969; etc.). Wir wissen auch, dass im Vergleich zu demographisch offenen Bevölkerungen in Isolaten ein höherer Grad von Endogamie und Konsanguinität zu finden ist. Die Folge davon ist eine Erhöhung der Häufigkeit von Homozygoten, wobei besonders der Anteil rezessiver Merkmale steigt. Eine Änderung des Endogamiegrades müsste infolgedessen einen bestimmten Einfluss auf Merkmalsverteilungen haben. LUNDBORG (1931) und DAHLBERG (1943) sahen als erste einen Zusammenhang zwischen der säkularen Körperhöhensteigerung und der durch Auflösung der Isolate verursachten Durchmischung der Bevölkerung. Damit übertragen sie die Erscheinung des Luxurierens auf die Vermischung von Varianten innerhalb von Populationen. Der Körperhöhe wird also eine additive Polymerie zugrundegelegt und für die Heterozygoten eine Summierung dominanter Grosswuchsallele angenommen — ein Phänomen, das man als Heterosis bezeichnet.

Es folgt eine Reihe von Untersuchungen über verschiedene Körpermasse in Beziehung zur Grösse von Heiratskreisen. In einer Studie von 1958 hat HULSE bei Endogamen eine kleinere Körperhöhe und eine stärkere Brachykephalie festgestellt. Andere Kopf- und Körpermasse wiesen keine deutlichen Unterschiede auf. Auch NOLD (1963) hat für den Breisgau nachgewiesen, dass die Körperhöhe mit der Entfernung zwischen den Geburtsorten der Eltern steigt.

WOLANSKI und Mitarbeiter (1970) fanden bei Stettiner Kindern, deren Eltern eine grosse Heiratsdistanz zeigten, eine Häufung positiver Korrelationen für grössere Körpermasse (Körperhöhe, Gewicht, Brustumfang). Das gleiche konnte auch FURUSHO (1965) für die Körperhöhe feststellen. Auch für Kopfmasse gibt es einige positive Ergebnisse. So z.B. fanden FERAK und LICHARDOVA (1969), dass Kinder dörflicher Herkunft aus exogamen Ehen grössere Kopflängen und geringere Kopfbreiten aufweisen im Vergleich zu Kindern aus endogamen Ehen.

Im Gegensatz zu dem Heterosiseffekt kann man in stark endogamen Kleinisolaten und bei konsanguinen Gruppen eine „Inzuchtdepression" feststellen. FURUSHO (1963) untersuchte die Körpergrösse von 663 Personen, die aus Nichtverwandtenehen stammen, und von 104 Personen, die aus Verwandtenehen hervorgingen. Er konnte bei den letzteren eine Tendenz zu niedrigeren Werten nachweisen. Auch SCHULL und NEEL (1965) kamen bei japanischen Kindern zu ähnlichen Ergebnissen. Gesammelte Daten aus 63 Departments in Frankreich zeigen eine gesicherte negative Korrelation von —0,32 zwischen Inzuchtkoeffizient und Körperhöhe (SCHREIDER, 1968). Das heisst, je höher der Inzuchtgrad in den Departments, desto niedriger die Körperhöhe.

Erwähnt werden muss auch, dass nach einigen Autoren diese „Inzuchtdepression" nach Alter und Geschlecht differenziert werden kann. MORTON (1958) stellt fest, dass im Bereich der Körperhöhe und des Gewichts der Neugeborenen signifikante, aber nur kleine Unterschiede zugunsten der nichtkonsanguinen Gruppe bestehen. In der schon erwähnten Studie von SCHREIDER (1967) werden die errechneten Korrelationen zwischen Inzuchtgrad verschiedener Departments und Körperhöhe in folgende Untergruppen eingeteilt:

1. Kinder im Alter von 7 Jahren
   a) Jungen —0,25
   b) Mädchen —0,24
2. Erwachsene
   a) Männer —0,44
   b) Frauen —0,56

Daran ist zu sehen, dass sich bei erwachsenen Frauen hinsichtlich der Körperhöhe „Inzuchtdepression" stärker auswirkt als bei Männern.

Es liegt aber auch eine Reihe von Untersuchungen vor, in der keine Inzuchtdepression oder Heterosiseffekt nachweisbar waren. KRIEGER (1969) z.B. fand keine gesicherten Unterschiede zwischen Kindern aus Verwandtenehen und Kontrollgruppen. In einer Arbeit über Körperhöhe und Heiratskreise konnte BECKMANN (1962) in Nordschweden zwar eine positive Korrelation zur Grösse des Heiratskreises nachweisen, in Mittelschweden jedoch übertrafen diejenigen, deren Eltern in der gleichen Gemeinde geboren waren, solche mit Eltern aus verschiedenen Gemeinden an Körperhöhe.

Sicher ist, dass zu solchen Studien nicht jede Bevölkerung herangezogen werden kann. Die lokalen oder endogamen Ehen einer Grossbevölkerung können nicht immer mit denjenigen einer Kleinbevölkerung verglichen werden. Eine beträcht-

liche Steigerung der Homozygotenzahl kann ebenso wie auch eine Inzuchtdepression nur in kleinen Gruppen, die seit vielen Generationen eine strenge Endogamie üben, erwartet werden.

Material und Methode

Genau die oben erwähnten Bedingungen (lange Isolation und kleine Individuenzahl) erfüllt die von uns untersuchte Bevölkerung. Die Daten stammen aus einer kleinen Gebirgsbevölkerung (Lindenfeld), die 1827 in Südosteuropa angesiedelt wurde.

Zuerst wurden in dieser Gebirgzone zwei Dörfer gegründet — Weidental und Wolfsberg — drei Jahre später zogen 18 Familien aus Wolfsberg weg und gründeten ein drittes Dorf — Lindenfeld. Weidental und Wolfsberg befinden sich in unmittelbarer Nähe und stehen in engen Heiratsbeziehungen zueinander. Lindenfeld ist ziemlich weit entfernt und durch keine fahrbaren Wege mit den anderen beiden verbunden. Da diese Bevölkerungen eine andere soziale Struktur (Religion, Sprache) haben im Vergleich mit den umliegenden Dörfern und die Heiratsbeziehungen zwischen Lindenfeld und den anderen beiden Dörfern stets zurückgegangen sind, bildeten sich im Laufe der Zeit zwei Isolate, die sich selbständig weiterentwickelten: einerseits Weidental und Wolfsberg mit einer grösseren Bevölkerung und andererseits Lindenfeld mit nur sehr wenig Individuen, deren Heiratskreis sehr beschränkt ist und in dem Endogamie und Konsanguinität von Generation zu Generation zugenommen haben.

Als wir die demographischen Parameter untersuchten, konnten wir auf mehrere Generationen zurückgreifen, was bei den anthropologischen Merkmalen nicht mehr möglich war. Hier mussten wir uns auf die jetzige Bevölkerung begrenzen. Da aus diesem Grunde die Individuenzahl klein war und wir nur Daten von Erwachsenen verwenden konnten, musste davon abgesehen werden, zwei Gruppen — eine konsanguine und eine nichtkonsanguine — zu bilden. Als Vergleichsmaterial benutzten wir die Bevölkerung von Wolfsberg und Weidental. Aus folgenden Gründen halten wir diese Vergleiche für sehr adäquat:

1. Die Bevölkerung der drei Dörfer hat dieselbe Abstammung und die 18 Lindenfelder Gründungsfamilien stammen aus Wolfsberg.
2. Im vorigen Jahrhundert gab es noch intensive Heiratsbeziehungen zwischen diesen Dörfern.
3. Die drei Dörfer liegen in derselben Gebirgszone mit gleichen klimatischen Bedingungen.
4. In den drei Dörfern findet sich eine gleiche, durch Tradition erhaltene Ernährungsweise.

Es wurden nur erwachsene, zwischen 20 und 50 Jahre alte Personen untersucht. Ein signifikanter Unterschied zwischen dem mitleren Alter der jeweiligen Gruppen bestand nicht. Die Stichproben enthalten in Wolfsberg 91 männliche und 97 weibliche und in Weidental 104 männliche und 98 weibliche Individuen. In Lindenfeld wurden alle Erwachsene, die altermässig zwischen den oben gennanten Jahresgrenzen lagen, untersucht. Dies ergab 41 männliche und 40 weibliche Individuen.

Ergebnisse

Ein Vergleich zwischen beiden Bevölkerungen, was Exogamie, Endogamie und Konsanguinität betrifft, ist in Tab. 1 angegeben.

Die Kopf- und Körpermasse sind in den Tab. 2 bis 5 aufgeführt.

Man erkennt, dass viele Mittelwerte ganz dicht beieinander liegen. Bei einigen Merkmalen treten jedoch auch Unterschiede auf. Darum haben wir den t-Test für jedes Merkmal und für je zwei Dörfergruppen berechnet (Abb. 1 bis 3). In diesen Figuren ist die Reihenfolge der Merkmale die gleiche wie in den Tab. 2 bis 5, d.h. von 1—12 sind die Kopfmasse angegeben, von 13—22 die entsprechenden Kopfindices. Nach dem horizontalen Strich folgen von 23—32 die Körpermasse und danach (33—40) die Körperindices. Betrachtet man die Figuren, dann zeichnen sich einige interessante Ergebnisse ab:

Tabelle 1. Endogamie, Exogamie und Konsanguinität in den beiden Bevölkerungen

Ort	Zahl der Familien	Endogame Ehen N	Endogame Ehen %	Exogame Ehen N	Exogame Ehen %	Konsanguine Personen N	Konsanguine Personen %	Inzucht-koeff. F
Weidental + Wolfsberg	752	586	77,9	166	22,1	240	11,7	0,002925
Lindenfeld	67	60	89,5	7 6*	10,4 8,9*	46	26,1	0,005489

* = zwischen Lindenfeld einerseits und Weidental und Wolfsberg andererseits

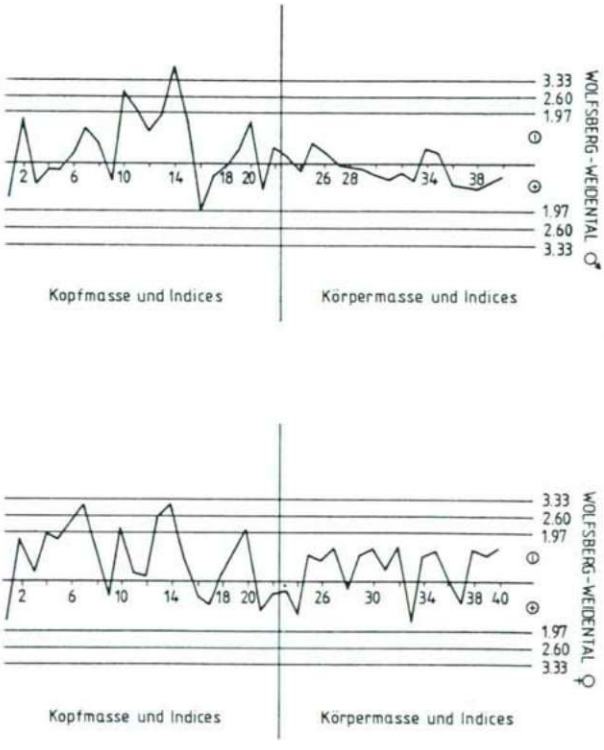

Abb. 1. Die T-Testwerte zwischen den Dörfern Wolfsberg und Weidental.

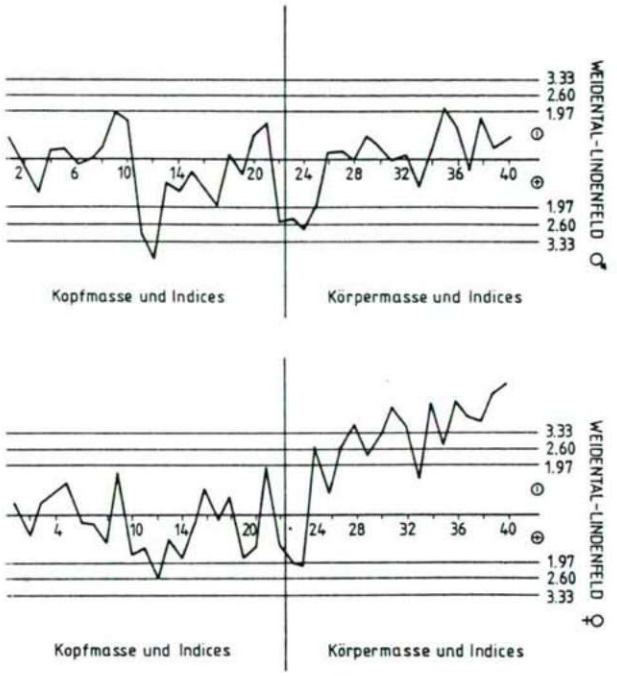

Abb. 2. Die T-Testwerte zwischen den Dörfern Weidental und Lindenfeld.

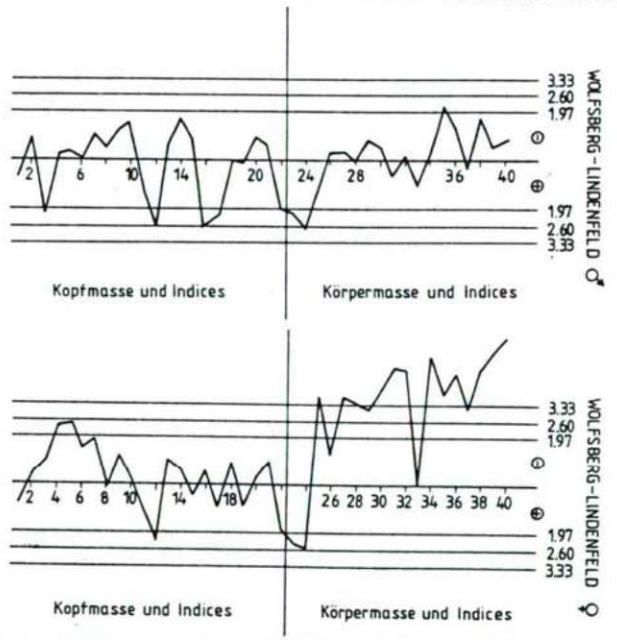

Abb. 3. Die T-Testwerte zwischen den Dörfern Wolfsberg und Lindenfeld.

Tabelle 2. Die Variabilität der Kopfmaße

	Merymal		Dorf	♂			♀		
				$\bar{x}$	γ	v	$\bar{x}$	γ	v
1	Kopflänge	(1)	Wolfsberg	187,0	6,07	3,23	178,8	5,89	3,29
			Weidental	186,6	6,06	3,25	177,6	5,64	3,18
			Lindenfeld	187,4	4,60	3,45	177,9	4,73	2,66
2	Kopfbreite	(3)	Wolfsberg	157,5	4,33	2,75	152,1	4,94	3,25
			Weidental	158,6	4,54	2,86	153,5	4,30	2,81
			Lindenfeld	158,2	5,54	3,50	152,5	4,48	2,93
3	Kleinste Stirnbreite	(4)	Wolfsberg	113,0	6,68	5,91	107,8	5,65	5,24
			Weidental	112,2	6,94	6,19	108,2	5,53	5,11
			Lindenfeld	110,4	5,64	5,11	108,7	5,06	4,65
4	Jochbogenbreite	(6)	Wolfsberg	142,7	4,91	3,44	133,8	5,15	3,84
			Weidental	142,5	5,72	4,01	135,2	4,13	3,05
			Lindenfeld	142,8	4,96	3,47	136,0	5,77	4,24
5	Unterkieferwinkelbreite	(8)	Wolfsberg	109,4	4,97	4,54	100,9	6,07	5,02
			Weidental	109,1	6,03	5,53	102,1	4,74	4,64
			Lindenfeld	109,5	4,60	4,20	103,3	5,86	5,67
6	Morphologische Gesichtshöhe	(18)	Wolfsberg	126,9	6,79	5,35	115,5	6,22	5,38
			Weidental	127,2	7,02	5,51	117,7	5,47	4,64
			Lindenfeld	126,9	6,30	4,97	117,3	6,65	5,67
7	Physiognomische Obergesichtshöhe	(19)	Wolfsberg	78,3	4,77	6,10	71,9	4,16	5,78
			Weidental	79,3	4,46	5,63	73,7	3,93	5,32
			Lindenfeld	79,2	4,74	5,98	73,4	3,54	4,82
8	Nasenhöhe	(21)	Wolfsberg	56,9	3,95	6,94	53,5	3,33	6,23
			Weidental	57,3	4,24	7,39	54,2	3,84	7,09
			Lindenfeld	57,3	4,11	7,17	53,5	3,19	5,97
9	Nasenbreite	(13)	Wolfsberg	33,7	3,00	8,91	31,5	2,77	8,79
			Weidental	33,3	2,50	7,48	31,3	2,13	6,80
			Lindenfeld	34,3	2,84	8,27	32,1	2,81	8,75
10	Ohrhöhe des Kopfes	(15)	Wolfsberg	120,7	4,86	4,02	117,2	4,66	3,97
			Weidental	122,8	4,56	3,71	118,7	4,21	3,55
			Lindenfeld	122,1	3,99	3,26	117,3	4,79	4,08
11	Ohrlänge	(29)	Wolfsberg	63,9	4,23	6,62	59,2	3,20	5,39
			Weidental	65,2	3,62	5,55	59,4	3,63	6,10
			Lindenfeld	63,0	4,06	6,44	58,5	3,85	6,58
12	Ohrbreite	(30)	Wolfsberg	36,6	3,30	9,03	32,9	2,47	7,50
			Weidental	37,7	5,29	14,02	32,9	2,41	7,32
			Lindenfeld	34,5	2,39	6,93	31,7	3,00	9,48

Tabelle 3. Die Variabilität der Kopfindices

	Merkmal	Dorf	♂			♀		
			$\bar{x}$	γ	v	$\bar{x}$	γ	v
13	Kopfindex	Wolfsberg	84,0	3,15	3,75	85,2	3,20	3,76
		Weidental	85,0	2,90	3,41	86,4	3,16	3,66
		Lindenfeld	84,4	3,70	4,38	85,8	2,69	3,13
14	Länge—Ohrhöhe—Index des Kopfes	Wolfsberg	64,3	2,56	3,98	65,6	2,80	4,27
		Weidental	65,8	2,67	4,05	66,9	2,68	4,01
		Lindenfeld	65,1	2,38	3,66	65,9	2,75	4,17
15	Breite—Ohrhöhe—Index des Kopfes	Wolfsberg	76,7	2,99	3,90	77,1	2,87	3,72
		Weidental	77,5	2,91	3,76	77,5	2,62	3,38
		Lindenfeld	77,2	3,28	4,25	76,8	2,88	3,76
16	Frontoparietalindex	Wolfsberg	71,8	4,20	5,86	70,9	3,62	5,10
		Weidental	70,6	4,00	5,66	70,6	3,36	4,76
		Lindenfeld	69,7	2,86	4,10	71,6	3,23	4,52
17	Jugofrontalindex	Wolfsberg	79,2	4,15	5,25	80,6	3,96	4,92
		Weidental	78,8	4,94	6,27	80,1	4,09	5,10
		Lindenfeld	77,3	3,19	4,13	79,9	2,96	3,70
18	Jugomandibularindex	Wolfsberg	76,7	3,46	4,51	75,4	2,37	3,14
		Weidental	76,6	3,50	4,58	75,5	3,11	4,11
		Lindenfeld	76,7	3,36	4,38	75,9	2,79	3,68
19	Gesichtsindex	Wolfsberg	88,9	5,14	5,78	86,3	4,41	5,11
		Weidental	89,4	5,33	5,96	87,1	4,16	4,78
		Lindenfeld	88,9	5,28	5,94	85,5	4,86	5,69
20	Physiognomischer Obergesichtsindex	Wolfsberg	54,8	3,50	6,40	53,8	3,14	5,84
		Weidental	55,7	3,45	6,20	55,0	4,34	7,90
		Lindenfeld	55,5	3,60	6,49	54,0	3,11	5,77
21	Nasenindex	Wolfsberg	59,4	6,26	10,55	59,1	5,88	9,95
		Weidental	58,4	5,39	9,23	58,2	5,43	9,34
		Lindenfeld	60,1	6,40	10,65	60,3	5,94	9,86
22	Ohrindex	Wolfsberg	57,3	4,46	7,78	55,6	4,55	8,20
		Weidental	57,9	8,03	13,86	55,3	3,72	6,73
		Lindenfeld	55,0	3,62	6,57	54,1	5,08	9,37

Tabelle 4. Die Variabilität der Körpermaße

	Merkmal		Dorf	♂			♀		
				$\bar{x}$	γ	v	$\bar{x}$	γ	v
23	Körpergröße	(1)	Wolfsberg	1694,9	61,55	3,63	1585,6	61,32	3,87
			Weidental	1697,4	60,79	3,58	1582,2	51,28	3,24
			Lindenfeld	1670,5	52,40	3,14	1558,7	68,78	4,41
24	Stammlänge	(23)	Wolfsberg	898,3	31,06	3,46	852,6	31,28	3,67
			Weidental	897,2	32,07	3,57	850,1	25,52	3,02
			Lindenfeld	881,8	29,06	3,30	838,3	34,66	4,13
25	Gewicht	(71)	Wolfsberg	67,1	8,18	12,20	59,4	10,70	18,02
			Weidental	68,4	10,85	15,86	61,1	10,19	16,69
			Lindenfeld	65,2	9,84	15,10	66,6	10,93	16,42
26	Schulterbreite	(35)	Wolfsberg	391,7	17,15	4,38	360,0	16,32	4,53
			Weidental	393,2	21,19	5,39	361,9	17,64	4,87
			Lindenfeld	392,9	15,37	3,91	364,5	14,80	4,06
27	Breite zwischen den Humerale		Wolfsberg	436,1	18,83	4,32	403,7	23,10	5,72
			Weidental	435,9	27,82	6,38	408,8	27,47	6,72
			Lindenfeld	438,2	23,27	5,31	421,4	24,34	5,78
28	Beckenbreite	(40)	Wolfsberg	282,9	16,34	5,79	279,8	21,28	7,60
			Weidental	281,2	20,22	7,17	279,0	20,07	7,19
			Lindenfeld	282,2	14,06	4,98	294,0	26,92	9,16
29	Hüftbreite	(42)	Wolfsberg	326,9	16,02	4,90	330,3	21,60	6,54
			Weidental	326,3	18,14	5,56	333,7	22,24	6,66
			Lindenfeld	329,8	18,22	5,52	344,5	25,27	7,33
30	Brustumfang	(61)	Wolfsberg	934,5	49,51	5,30	858,9	67,7	7,88
			Weidental	929,2	72,31	7,78	871,4	64,6	7,42
			Lindenfeld	942,5	64,77	6,87	911,0	69,1	7,58
31	Hüftumfang	(64(1)	Wolfsberg	923,0	33,91	5,84	957,6	75,75	7,91
			Weidental	916,8	56,72	6,19	963,6	77,36	8,03
			Lindenfeld	916,2	60,81	6,64	1033,0	99,18	9,60
32	Größter Oberschenkelumfang	(68)	Wolfsberg	505,7	38,84	7,68	539,9	49,87	9,24
			Weidental	502,8	45,49	9,05	553,2	66,03	11,94
			Lindenfeld	507,3	55,45	10,93	595,4	67,16	11,28

Tabelle 5. Die Variabilität der Körperindices

	Merkmal	Dorf	♂			♀		
			x̄	γ	v	x̄	γ	v
33	Relative Stammlänge	Wolfsberg	53,0	1,39	2,62	53,8	1,22	2,27
		Weidental	52,9	1,28	2,43	53,5	1,16	2,17
		Lindenfeld	52,8	1,17	2,21	53,8	1,41	2,62
34	Rohrerindex	Wolfsberg	1,38	0,16	11,89	1,49	0,23	15,45
		Weidental	1,40	0,20	14,55	1,52	0,22	14,29
		Lindenfeld	1,39	0,18	13,27	1,74	0,31	18,16
35	Relative Schulterbreite	Wolfsberg	23,1	0,84	3,63	22,7	0,86	3,80
		Weidental	23,2	1,13	4,90	22,9	0,93	4,07
		Lindenfeld	23,5	1,08	4,60	23,4	1,02	4,37
36	Relative Beckenbreite	Wolfsberg	16,7	0,88	5,27	17,6	1,22	6,90
		Weidental	16,6	1,00	6,02	17,6	1,25	7,06
		Lindenfeld	16,9	0,81	4,81	18,8	1,71	9,10
37	Rumpfbreitenindex	Wolfsberg	72,1	4,08	5,65	77,7	5,05	6,49
		Weidental	71,6	4,25	5,94	77,0	5,02	6,52
		Lindenfeld	71,9	4,19	5,83	81,2	7,15	8,81
38	Relativer Brustumfang	Wolfsberg	55,2	3,21	5,81	54,2	3,96	7,30
		Weidental	54,6	3,95	7,22	55,1	4,12	7,48
		Lindenfeld	56,4	3,71	6,57	58,2	4,90	8,42
39	Relativer Hüftumfang	Wolfsberg	54,4	2,96	5,45	60,2	4,72	7,84
		Weidental	54,1	3,17	5,87	60,9	4,89	8,02
		Lindenfeld	54,8	3,15	5,76	65,8	6,73	10,22
40	Relativer Oberschenkelumfang	Wolfsberg	29,8	2,25	7,54	34,0	3,00	8,82
		Weidental	29,6	2,69	9,08	34,7	3,27	9,41
		Lindenfeld	30,3	3,09	10,18	38,1	4,54	11,90

Zunächst die morphologische Einheit der drei Dorfbevölkerungen im Bereich der Kopf-Gesichts-Mekmale. Sowohl bei den Frauen als auch bei den Männern gibt es nur wenige, meist schwach signifikante Unterschiede, etwa bezüglich Länge und Breite der Ohrmuscheln.

Betrachten wir aber die untersuchten Körpermasse, so ergibt sich ein völlig neues Bild. Zwischen Wolfsberg und Weidental, den zwei nebeneinanderliegenden Dörfern mit engen Heiratsbeziehungen, treten bei keinem der beiden Geschlechter irgendwelche Unterschiede auf. Vergleicht man dagegen die beiden Dörfer mit Lindenfeld, dann ergeben sich bei den Frauen hoch signifikante Unterschiede. Abgesehen von Schulterbreite und relativer Stammlänge unterscheiden sich die Frauen aus Lindenfeld signifikant in allen anderen untersuchten Körpereigenschaften von den Frauen der beiden anderen Dörfer. So sind z.B. die Körperhöhe und die damit korrelierte Sitzhöhe der Frauen aus Lindenfeld wesentlich kleiner, alle anderen Masse und Indices allerdings, mit Ausnahme der schon oben erwähnten, signifikant grös-

ser. Bei den Männern erscheint dieses Bild nur im Bereich der Körper- und Sitzhöhe, die ebenfalls signifikant kleiner sind. Eine erste Erklärung, die diese Differenzen begründen könnte, wäre ein eventueller fremder Genfluss innerhalb der beiden Bevölkerungen. Nach allen Angaben war aber dieser Genfluss in den letzten zwei bis drei Generationen, seitdem die Heiratsbeziehungen zwischen den beiden Isolaten sehr zurückgegangen waren, so gering, dass diese Mischehen in keinem Fall derartige Differenzen erklären könnten. Eine solche Annahme wird auch durch die morphologische Einheit der Kopf- und Gesichtsmerkmale in Frage gestellt. Darum glauben wir, dass die geringere Körperhöhe der Männer und Frauen aus Lindenfeld als ein Effekt der höheren Konsanguinität und Endogamie jener Bevölkerung angesehen werden muss. — Wie könnte man diese Inzuchtdepression erklären?

Die Inzuchtdepression dürfte nach SCHWIDETZKY (1971) darauf beruhen, dass bei polyfaktoriellen Grössen (z.B. Körperhöhe) innerhalb der Vielzahl der beteiligten Gene diejenigen für niedrigere Werte häufiger rezessiv sind als diejenigen für höhere. Obwohl dieses Problem umstritten ist und viele Autoren anderer Meinung sind, möchten wir hier noch zwei Beispiele aus der Literatur erwähnen. 1959 konnte GREBE nachweisen, dass eine Vielzahl rezessiver Erbanlagen für extremen Kleinwuchs verantwortlich ist. Ein zweites Beispiel wäre der von GATES (1949) aufgezeichnete Stammbau einer amerikanischen Negerfamilie. Aus einer zweimaligen Vetter-Basen-Ehe zwischen hochwüchsigen Individuen sind ausschliesslich kleinwüchsige Kinder, und zwar sieben, hervorgegangen. Nach GATES lässt sich dieser Befund durch die Annahme deuten, dass in den Vetter-Basen-Ehen rezessive Allele für Kleinwuchs an einem oder mehreren Genloci zur Homozygotie zusammengetreten sind.

Eng verbunden mit diesem Aspekt ist auch ein zweiter. In Wolfsberg und Weidental erhalten wir für die Körperhöhe eine Normalverteilung. Dagegen zeichnet diese Verteilung bei den Frauen von Lindenfeld eine Kurve mit zwei Spitzen auf. Eine Spitze liegt im Bereich der kleinen, die andere im Bereich der übermittelgrossen Körperhöhen (Körpergrössenskala nach E. SCHMIDT*). Bei den Männern verläuft diese Kurve stark asymmetrisch mit einer Tendenz zur Anhäufung von kleineren Körpergrössen (Abb. 4), was auch die signifikant kleineren Mittelwerte im Vergleich zu Wolfsberg und Weidental erklärt.

* Eintellung der Körpergrösse nach E. Schmidt:

	♂	♀
sehr klein	x—152,9	x—141,9
klein	153—162,9	142—150,9
untermittelgross	163—166,9	151—154,9
mittelgross	167—169,9	155—157,9
übermittelgross	170—172,9	158—159,9
gross	173—182,9	160—169,9
sehr gross	183—203,9	170—188,9

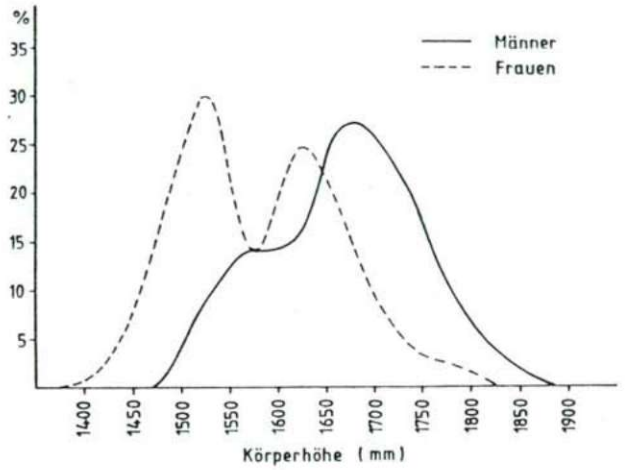

Abb. 4. Die Verteilung der Körperhöhen in Lindenfeld.

Berücksichtigen wir, dass diese Bevölkerungen gleicher Abstammung sind und gleiche Lebensbedingungen aufweisen, so scheint die Anhäufung von kleinwüchsigen Personen das Ergebnis eines hohen Grades von Konsanguinität und Endogamie zu sein. In diesem Falle könnten wir annehmen, dass bestimmte rezessive Gene in homozygotem Zustand Kleinwüchsigkeit verursachen. Wir versuchten, diese Annahme anhand von ein paar konsanguinen Familien zu überprüfen. Von den erwachsenen 20 bis 50-jährigen Personen stammen 24 aus Verwandtenehen. Von ihnen zeigen 16 (66,7%) kleine und untermittelgrosse Körpergrössen auf, während der Rest mittel-, übermittelgross oder gross ist.

Diese Zahlen zeigen uns zwar eine Tendenz, aber die Individuenzahl ist zu klein, um eine bestimmte Aussage vertreten zu können. Zudem spricht gegen diese Hypothese die Tatsache, dass aus konsanguinen Familien auch grosswüchsige und aus Nichtverwandten-Ehen auch kleinwüchsige Nachkommen geboren wurden. Man muss dabei aber bedenken, dass einerseits Konsanguinität nicht in jedem Fall zu Homozygotie führen muss und andererseits, dass aufgrund von hoher und lang anhaltender Endogamie auch bei Nachfolgern von Nichtverwandten-Ehen rezessive Gene häufiger zusammentreffen können.

Schwierig ist, eine Behauptung aufzustellen, wie diese genetischen Mechanismen verlaufen. Dies ist auch nicht der Zweck dieser Arbeit. Klar ist nur, dass Inzucht und Endogamie eine „Depression" hervorrufen, die sich in diesem Fall auf Körperhöhe und die damit korrelierten Eigenschaften auswirkt.

Was die anderen Körpermasse betrifft — vorwiegend die Umfänge, bei denen zwischen den Frauen aus Lindenfeld und den Frauen aus Wolfsberg und Weidental hoch signifikante Unterschiede auftreten — so wird eine Erklärung noch schwieriger. Auffälig dabei ist aber, dass die grössten Differenzen im Bereich derjenigen Merkmale erscheinen, bei denen die Dicke der Weichteile die grösste Rolle spielt.

Aus diesem Grunde könnte man als erste Ursache den Ernährungsfaktor vermuten. Wie schon erwähnt, haben jedoch beide Bevölkerungen die gleiche Ernährungsweise und beide wurden innerhalb einer Woche von uns untersucht. Ausserdem ist schwer vorstellbar, dass eine unterschiedliche Ernährung sich nur bei Frauen auswirkt. Da dieses Phänomen aber nur in Lindenfeld auftritt, muss es schon mit der Isolation und der hohen Konsanguinitätsrate dieser Bevölkerung in Verbindung gebracht werden.

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OCCURRENCE OF EARLY FETAL DEATH BEFORE AND AFTER THE CHERNOBYL CATASTROPHE

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Abstract

The authors studied the possible reasons of the increased rate of missed abortions observed in the Heves County Hospital during the last four years in the city of Eger and its surroundings. They found that while in 1983—1985 there were only 127 missed abortions (1.1%) verified by clinical and biological tests, in 1986—1988 (till 31 Dec.) that number verified by clinical and ultrasonographic method has increased to 237 (1.8%). Considering the 57 000 female population of reproductive age 0.74 missed abortions/1000 women occurred in the first period of investigation; during the next 3-year period this ratio increased to 1.4%. In their opinion the reason of high ratio of missed abortions is the environment pollution. Gametic cells are very susceptible to chemical and radioactive substances and may induce spontaneous abortions. Further studies will clarify whether the radioactive pollution induced by the catastrophe was higher.

Key words: missed abortion, outcome of pregnancy, radioactive load, Chernobyl.

Introduction

In the past four years however, the occurrence of the intrauterine deaths during the first and second trimesters has markedly increased (FARKAS et al., 1989).

These observations made us to investigate the reasons of the increased frequency of missed abortions.

The occurrence of occult (inapparent) abortions supported by clinical and laboratory studies can reach 26—43% (LAMPÉ, 1987; SZILÁGYI and NAGY, 1985).

Spontaneous abortion ratio in most of the textbooks is given as 10—15%. Considering the inapparent abortions, however, increases this ratio to 28% (LAMPÉ, 1987).

Various reasons elicit spontaneous and incomplete abortions and fetal death, still in most of the cases the exact reason can not be exactly established post factum.

Ultrasonography plays a crucial role in proving the diagnosis of missed abortion. Negative findings showing that the embryo is alive occur in 79%, while the prognostic value of the pathologic positive findings was 100% (HERNÁDI et al., 1989).

Material and methods

Between 1983 and 1989 we followed up the outcomes of pregnancies of all the pregnants treated at the Department of Obstetrics and Gynaecology of the Heves County Hospital. Of the pathological factors preventing the normal outcome of pregnancy, an unusually high frequency of missed abortions occurred to the investigators. Thus we tried to elucidate its possible reasons. All the gestations of these seven years were assessed into two groups (3 years each). The gestations of 1989 were separately analysed.

We observed 127 missed abortions during the first period, with near similar yearly occurrence of these pathological events. During the second 3-year period there were 237 cases of missed abortions, their frequency showing an increasing tendency since 1986. We found 100 missed abortions in 1989. We have calculated the frequency of missed abortions/1000 women of reproductive age in each group using equations for linear ($y = a + bx$) and exponential ($y = \exp/a + bx/$) regression. Siginificant differences were calculated using a t-test.

All spontaneous abortions were subdivided into two groups: incomplete abortion and missed abortion.

Apart from the clinical study, two other possibilities exist for determination of the development and actual state of pregnancy: these are the determination of hormon levels and ultrasonography.

HCG is determined on the next day after admission from the first morning urine sample (Menotest-Chinoin). Ultrasonography is performed with a BRUEL-KJAER 1846 real-time sector system equipment with frequencies of 3 and 5 MHz.

Absence of heart beats is the most important feature of the diagnosis of missed abortion. Real-time equipment provides a possibility to determine heart function already on the 7th-8th gestational week. Over the 15 mm „sitting position" it can be determined in all cases.

Results

While between the 1983 and 1985 the occurrence of missed abortions supported by clinical and biological tests was only 127 (1.1%), it has increased from 1. Jan. 1986 to 31. Dec. 1988 to 237 (1.8%). Clinical diagnosis was always supported by ultrasonography and proved to be correct. By the time of the operation in most cases biological test also gave positive results. Histology always proved abortion.

It is noteworthy that while the yearly frequency of missed abortions during the first period was about the same, it showed an increasing tendency in the second period. The absolute value and frequency of missed abortions in 1987 was extremely high (89 = 2.2%). It was twice as high, as the mean value of the first period.

Between 1983 and 1985 127 missed abortions occurred (yearly frequency 42.3). Considering the 57 000 female population of reproductive age, there are 0.74 missed abortions/1000 women. After the Chernobyl catastrophe 237 missed abortions (79/year) occurred in the second 3-year period. As far as the female population of reproductive age remained unchanged, the occurrence of missed abortions/1000 women of fertile age increased to 1.4 (Fig. 1).

We found a significant increase in the occurrence of missed abortions in the period between 1983 and 1989 ($x^2 = 20.765$; p 0.05). The following results were obtained with linear and exponential regressions:

1. Both, the linear and the exponential fitting showed significant correlation between the data obtained in June and July and the years of study.

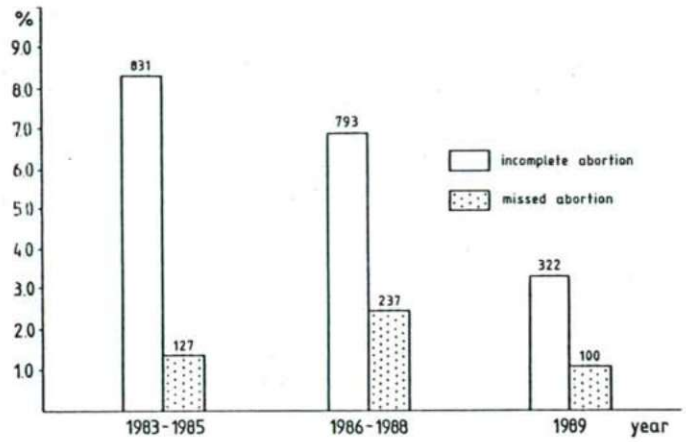

Fig. 1. Ratio of missed and incomplete abortions in 1983—1985, 1986—1988 and 1989

2. Linear fitting also showed significant relationship between the data obtained in September (p 0.05) and the years of study.

3. In other cases we found no relationship between our data and the years or the number of the dead embryos.

Analysis of these data (1—3) indicates that a reliable prognosis for the same periods of the years of 1990, 1991, 1992 can be made only for the months studied in 1. and 2. (Fig. 2).

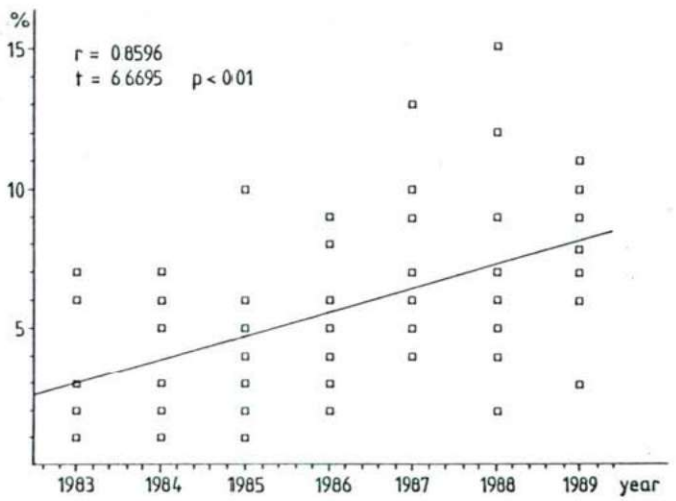

Fig. 2. Yearly and monthly occurrence of missed abortions between 1983 and 1989 (□ — monthly occurrence of missed abortions)

Discussion

A significant increase of missed abortions can not be incident, because other factors inducing possible damages of the gametes remained unchanged.

Missed abortions increasing since 1986 can be rather explained by the biological effects of the elevated radiation levels or may be the sequellae of the genetic mutations.

We have no data on the exact radiologic activity, however the increase of missed abortions interpreted as a „biological dose" indirectly suggests that the damage of the parental gametes might elicit the increased frequency of missed abortions.

Our data support the opinion of LÜNING el al. (1989), that factor of uncertainty makes the character of the effects of radioactive pollution on the human organism extremely complex. STEWART et al. (1958) showed that the smalldose radiation, for example a simple X-ray study can damage the fetus.

The increased rate of fetal and infant mortality and the malignant diseases of childhood are well documented in literature (STEWART et al., 1958; KNEALE et al., 1987). Perhaps the radioactivity level in several areas of the Heves County could induce more damages, compared to the other parts of the country.

Data of the National Institute of Radiobiology and Radiohygiene deny that many highly radioactive products would still occur in Hungary. According to these data long-life radioactive cesium could be observed in some nutritients till November 1988; in low concentrations in milk and chicken (below the detectable limit of 1 Bq/kg), and at the low level below 4 Bq/kg in pork, mutton and beef. Hungarian data indicate that the radioactive load of the population exceeded the natural yearly dose (about 1.75 mSv) by 3—50% in 1986. The teratologic threshold in Hungary is accepted at the value of 10 rad (100 mSv); at the values exceeding this threshold abortion is indicated. The level of the background radiation after Chernobyl catastrophe did not approach this critical value (CZEIZEL and BILLEGE, 1988).

MOSER and ROEDLER (1987) showed that following the Chernobyl catastrophe that 30% of radioactive substances detected in the soil consisted of I^{131} and 40% of Te^{132} together with the products of decay originating from I^{131}.

Thyroid gland was found to bind 10 times more iodide than the gonades.

Our results support the data of SARKAR et al. (1976): the average radioactivity level in these patients exceeded 7.3 GBq/day, and ovarium got 0.3 Sv (30 rem). The authors conclude that the gonade dose of the released I^{131} was so low, that been compared to the natural yearly radioactive exposition and its deviations it can not elicit any genetical effects.

LECHNER et al. (1986) found that the breast milk of a women who has not limited her food consumption contained 7.4 nCi/l of gamma, and 7.6 nCi/l of beta activity.

GOLDMAN (1986) who has been sponsored by the Department of Energy (DOE) studied the medical sequelleae of the Chernobyl catastrophe in the European Countries outside the Soviet Union. His data indicate that during the following 50-year

period there will be 21 000 more patients with cancer. Cesium 137 is the most dangerous radionuclide, for its halflife period is 30 years (GOLDMAN, 1987). Using the data of MORE et al. (1981), MOLE and PATH (1987) evaluated the relationship between the in utero head circumference of human embryos and the first 100 days of pregnancy. Their next step was the evaluation of neonatal mortality of mice following intrauterine exposition of embryos to various doses of irradiation using the available data of RUSSEL (1954). The authors found that the rate of irradiational intrauterine damages of human embryos is rather due to the effect of the ionizating irradiation on cell colonies, than on the individual cells of the fetus.

TRICHOPOULOS et al. (1987) analyzing the birth trends in Greece calculated that 23% of the desired pregnancies have been terminated in May 1988 because of the fear of the consequences of Chernobyl catastrophe, despite the fact that the average radiation level in Greece did not exceed 1 mSv.

CZEIZEL and BILLEGE (1988) state that Chernobyl catastrophe had no teratologic effect on Hungarian population. They found however, that a significant, higher than 9%, frequency of live births of infants with body weight lower than 2500 g observed in May and June of 1986 had never occurred in the past decade. They explain this phenomenon by psychosocial stress induced by the catastrophe.

LÜNING et al. (1989) studied the effect of radioactive pollution of the Chernobyl catastrophe on the infants who have been born immediately after the catastrophe. The early infant and perinatal mortality closely followed the mathematical model. Between 1975 and 1985 the infant mortality showed an exponential decreasing tendency. After the Chernobyl catastrophe however, significant changes have been observed especially in the southern areas presumably more effected by the radioactive pollution. In the authors' opinion this phenomenon is due to the direct effect of the increased radiation level. Further studies will clarify whether the radioactive pollution induced by the catastrophe was higher, compared to the officially published data and show the necessity of the revision of the critical radioactive load values. The warning data of statistical analysis are worth further investigation.

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THE OSTEO-ARCHAEOLOGICAL EVIDENCE OF VERTEBRAL TUBERCULOSIS IN THE 8TH CENTURY

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Abstract

A paleopathological examination of the human skeletal remains from the Avar-Age cemetery of Bélmegyer has been carried out. By course of the examination, the Author diagnosed a highly probable case of vertebral tuberculosis. The vertebral remains of a female skeleton produced the typical osteological features of an advanced-stage tuberculous spondylodiscitis (POTT's disease). The differential diagnosis was based on examinations using macroscopic morphological and radiological methods.

Key words: paleopathology, Avar Age, tuberculosis, POTT's disease.

Introduction

Tuberculosis is a chronic infectious disease caused by different strains of *Mycobacterium tuberculosis, (M. bovis,* or, rarely *M. avium*) (BÉLÁDI et al., 1978). The pulmonary tuberculosis is the most common form of the disease. However, the bacilli can also be disseminated from the lung and cause disease in other parts of the body, notably in the cervical and axillary lymph nodes, in bones and joints and in the genito-urinary system (LAPIS, 1989).

Although, only about 1% of all the tuberculotic cases involves the bones and joints (GÖMÖR and BÁLINT, 1989), this represents one of the most important joint disease of inflammatory origin.

What the skeletal localistion of the lesions concerns, the four major sites of skeletal tuberculosis are: -the vertebral column, -the hips, -the knees, and -the elbows (SEZE and RYCKEWAERT, 1983).

Statistical data reveal that the spine is the most common location for tuberculosis and, because of its anatomical position and relation to the central nervous system, it is also the most serious among the locations (MARTINI, 1988). The disease starts in the spongy substance of the vertebral body and eventually the intervertebral disc becomes eroded and some adjacent vertebrae can be involved, too (PARSONS, 1980).

The first report on presumptive tuberculosis in osteo-archaeological material was published by BARTELS in 1907 (in: REGÖLY-MÉREI, 1962).

Since that, the description of vertebral tuberculosis can be found in most of the general paleopathological studies, from the early period of paleopathology up till now (MOODIE, 1923; PALES, 1930; WELLS, 1964; ZIMMERMAN and KELLEY, 1982).

Materials and methods

A paleopathological investigation of the 234 skeletons belonging to the late Avar-Age cemetery (8th century) of Bélmegyer-Csömöki Hill (Eastern part of Hungary) has been carried out. The skeletons can be found in the collection of the Department of Anthropology, József Attila University. Looking for the skeletal symptomps of other diseases, a possible case of vertebral tuberculosis was detected. The present paper is a case report about the skeletal remains of the grave Nr. 65.

The aim of our study is the paleopathological diagnosis and interpretation of the detected pathological features.

The differential diagnosis was based on macromorphological and X-ray methods. The radiological analysis was carried out at the Department of Radiology of the Szeged Hospital.

Results and Discussion

The determination of sex and age of the skeletal remains coming from the grave Nr. 65 (Finding Nr. 10047) of the Bélmegyer-cemetery was made by traditional methods used in historical anthropology (FARKAS, 1972; MARTIN and KNUSSMANN, 1988).

The skeleton belongs to a 30 to 40 year old female. The remains are in a medium state of preservation. The spine is rather incomplete: 4 cervical, 10 thoracic and 4 lumbar vertebrae serve for the subject of examinations.

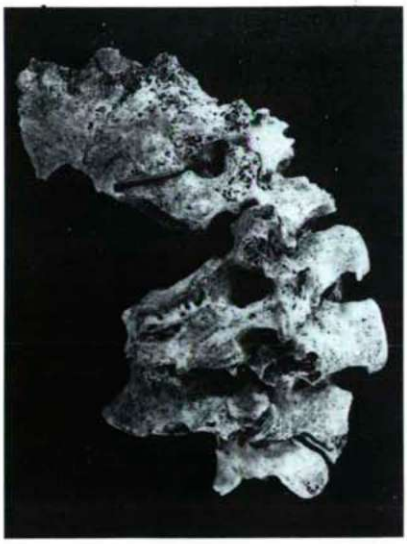

Fig. 1. Spinal remains showing angular kyphosis.

The fragments of the thoracic spine show serious pathological deformations (Fig. 1). There is a collapse and ankylosis among the bodies of the 8th and 11th thoracic vertebrae. The anterior portion of the bodies are most seriously involved and the unequal collapse results an angular posterior deformity (kyphosis). Angular kyphosis is also clearly expressed in the lumbar spine. The first, second and third vertebrae are ankylotic. The radiograph (Fig. 2) shows serious destructions of the vertebrae. The first area of involvement extends from T-8 through T-12, the second one from L-1 through L-4. Massive destruction, collapse, and severe kyphoscoliosis are evident at T-8 to T-11. The collapsed bones also display extensive fusion of the bodies and articular processes. The fragments of the lumbar spine show similar alterations.

Fig. 2. Radiograph of vertebrae seen on Fig. 1. Ankylosed vertebrae.

As a result of the spondylodiscitis, the vertebral body of the second lumbar vertebra got completely destroyed. Severe destruction of the third lumbar vertebra can be seen on Fig. 3. Only T7-8, T11-12, T12-L1 and L4-L5 disc spaces remain.

No other pathologic lesions on this skeleton could be found.

As we know from the literature, the tuberculotic changes of the spine are usually found in the lower thoracic and/or in the upper lumbar portion (KELLEY and EL-NAJJAR, 1980; MANCHESTER, 1983).

Developing differential diagnosis the tuberculotic features should be separeted from spondylitis non specifica and healed fracture (ORTNER and PUTSCHAR, 1981). In spinal osteomyelitis, the massive destruction of several vertebral bodies leading to a sharply angulated gibbus is uncommon (BODA, 1985). In compression fracture with angular deformity, usually only one vertebra is involved with a diagonal break, and there is a much less extensive destruction of the vertebral body (BARTA, 1986). In me-

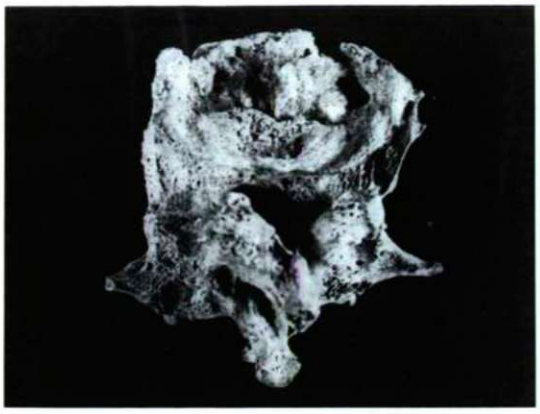

Fig. 3. Inferior view of the 3rd lumbar vertebra. Severe destruction of the vertebral body.

tastatic carcinoma the intervertebral disc is not destroyed (ENDES, 1983), consequently it can be disclosed.

The above mentioned morphological and radiological changes emphasise the occurrence of vertebral tuberculosis (HORVÁTH and FORGÁCS, 1984), but cases in which two different lesions are separeted by at least one intact vertebral are not common (MARTINI, 1988).

In the Bélmegyer-series a second possible case of tuberculosis — leading to the destruction of the hip joint of an other individual — was found too. Consequently, the frequency of joint tuberculosis is about 0,8% in the Bélmegyer-population. This value does not differ significantly from the data of other authors concerning historical periods (GLADYKOWSKA-RZECZYCKA, 1984; KRAMAR, 1987; DUTOUR et al., 1989). What the Avar-Age cemeteries concerns (MARCSIK, 1972; FARKAS et al., 1976; MARCSIK, 1977), the prevalence of the disease recognised is usually around one percent.

In order to be able to carry out a better epidemiological analysis of the disease we must examine numerous further populations from different historic periods.

Acknowledgement

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Short communication

PACLOBUTRAZOL INCREASES WOUND-INDUCED ETHYLENE PRODUCTION IN PRIMARY LEAVES OF BEAN SEEDLINGS

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Paclobutrazol (/2RS,3RS/-1-/4 -chlorophenyl/-4,4-dimethyl-2-/1,2,4-tiazol-1-yl/pentan-3-ol), like other growth retardants (SAUERBREY et al., 1987, 1988; GROSSMANN, 1990) is known to inhibit stress ethylene production (WANG and STEFFENS, 1985).

When seeds of bean (*Phaseolus vulgaris* L. cv. Juliska) had been soaked in 10 mg/l paclobutrazol solution and then were grown in sterile vermiculite under controlled conditions (NAGY et al., 1991) the retardant proved to be very effective for inhibiting shoot elongation and leaf area expansion.

In earlier experiments we found higher indole-3-acetic acid (IAA) level in the blades of primary leaves of 14-day-old plants than in the control (NAGY et al., 1991).

The ethylene production of vegetative tissues is thought to be regulated by the amount of internal free IAA (YANG and HOFFMANN, 1984), which stimulates ethylene biosynthesis by inducing the synthesis of the immediate precursor of ethylene, 1-aminocyclopropane-1-carboxylic acid (ACC). At the same time in most of the cases plant growth retardants exercise influence on the last step in ethylene biosynthesis, conversion of ACC to ethylene (SAUERBREY et al., 1988, GROSSMANN et al., 1989).

In present paper we investigated the result of these two, theoretically opposite effects on the ethylene production of primary leaves of bean (Table 1 and 2.).

Table 1. Effect of excision on ethylene production in primary leaf blades of paclobutrazol-treated 14-day-old bean plants

Time intervals after excision (hours)	Ethylene production (nl. fresh weight^{-1}. g^{-1})	
	control	treated
0— 1	2,57±0,21	2,93±0,33
1— 6	11,87±1,09	34,54±5,27
6—24	13,94±1,41	24,92±2,85

(Mean±SE, n=5)

Ethylene samples were withdrawn at given time intervals from 100 ml gas tight flasks containing plant material and analysed by gas chromatography as described earlier (NAGY et al., 1991). After each determination flasks were aerated and resealed.

Table 2. Time-course of excision-induced ethylene production in primary leaf blades of paclobutrazol-treated bean plants

Time (days)	Ethylene production (nl. fresh weight^{-1}. g^{-1}. 6 h^{-1})	
	control	treated
7	4,19±0,59	7,57±1,07
14	10,71±1,67	42,91±3,82
18	11,44±2,05	24,73±1,62
21	2,79±1,45	8,78±1,21

(Mean±SE, n=5)

Otherwise as in Table 1.

In blades of primary leaves paclobutrazol resulted in an increase in excision-induced ethylene production.

These data suggest that the inhibition of ethylene biosynthesis by retardants in cell suspensions or in leaf discs treated directly with test solutions cannot be extended over the all parts of a treated plant.

The effect of paclobutrazol on ethylene formation in an organ of treated seedlings will depend on the balance of the level of other endogenous plant growth regulators.

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Short communication

A NEW HABITAT OF DACTYLORHIZA INCARNATA (L. 1755) SOÓ 1960 IN HUNGARY

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(Received: September 1, 1990)

Dactylorhiza incarnata (L) SOÓ is not one of the most rare plant species in Hungary, but at the south-eastern part of the Great Hungarian Plain it is rather rare or is known from few places. In 1989 we discovered a new habitat of this plant which is out of its known area at the Plain, and which may increase that area, respectively.

Synonyms: *D. strictifolia* RAUSCHERT — *Dactylorchis incarnata* VERMLN. — *Orchis incarnata* L. — *O. impudica* CR. — *O. lanceata* DIETR. — *O. strictifolia* OPIZ. — *O. latifolia* PUGSLEY, NEWSKI.

Fig. 1. *Dactylorhiza incarnata* (L. 1755) SOÓ 1960

Dactylorhiza incarnata (L) SOÓ is an Eurasian, Erosiberian element of flora from the Atlantic ocean to the Trans-Baikalian region. The northern border of its

area is 65—70 degree of latitude, it is absent in the Mediterranean, but ranges to North Afrika dissolving in *D. elata* (POIR.) SOÓ formcircle (BORSOS, 1960).

It occures mainly on lowlands, but also on collin-submontanic, and sporadically on alpin regions.

Its demand on habitat: calciphilous, wet or changing moisture content, rich in nutrients, neutral humous clay, abode or sandy soil.

Molinion character species (SOÓ, 1973).

Detailed description of the area of *Dactylorhiza incarnata* (L) SOÓ can be found in BORSOS (1960) and SOÓ (1960). Its appearance is sporadical or rare in the Pannonicum and Carpaticum in the Mountain region and in the Carpathians, and frequent at the Plain.

The appearance at the Great Hungarian Plain can be located mainly at the north-western part of the area between Danube and Tisza, and at the Mezőföld, and sporadically at the southern region of Danube valey and Nyírség (the map of its area is in BORSOS, 1960).

The known habitats nearest to Szeged are as follows:

At the area between Danube and Tisza: Szabadka „Ludaspuszta" (Prodan), Kalocsa, Kecel (Boros), Bugac (Soó), Kiskőrös „Kiscsengődi forest", „Szücsi forest", Tabdi (Boros), at the South Zombor-Gombos-Szond (Prodan), and Bácska (Slavnic), (cit. in Borsos 1960).

Only two data is known from the eastern region: Makó (SOÓ and MÁTHÉ, 1938) and Temesvár (TŐKÉS, cit. in BORSOS, 1960).

The nearest data to the new habitat came from Makó (40 km) from the beginning of this century, and has not been confirmed since that time. The distance from the habitat near Szabadka is about the same, that from Bugac is 55 km, and from Kecel is 65 km.

The new habitat of *Dactylorhiza incarnata* was discovered at May 1989. It is situated 10 km north-west from Szeged, near Domaszék, north from the village (Fig. 2.). It is about a 5 ha part of a 15 ha marsh-meadow, surrounded by ploughlands. We estimated about 1000 individuals in 1989, but 3000 individuals in 1990 on the basis of several counts.

The soil of the habitat is fenny meadow soil developed on chalky sand. It is covered with *Molinietum caeruleae* (ALLORGE 22) W. KOCH 26 association, species composition of which is the following, with dominance classes:

D3: *Carex distans, Rhinanthus angustifolius;* D2: *Centaurea jacea, Dactylorhiza incarnata, Equisetum palustre, Festuca arundinacea, Iris sibirica, Molinia caerulea, Phragmites australis, Poa pratensis, Poa trivialis, Sanguisorba officinalis, Serratula tinctoria;* D1: *Carex acutiformis, Dactylis glomerata, Galium palustre, Koeleria javorkae, Lithrum salicaria, Orchis laxiflora* ssp. *palustris, Potentilla reptans, Ranunculus repens, Ranunculus sardous, Mentha aquatica, Trifolium pratense, Vicia cracca;* D+: *Achillea asplenifolia, Asperula cynanchica, Caltha palustris, Genista tinctoria, Linum perenne, Lotus corniculatus, Plantago lanceolata, Polygala comosa, Scorzonera parviflora, Taraxacum palustre, Thalictrum flavum.*

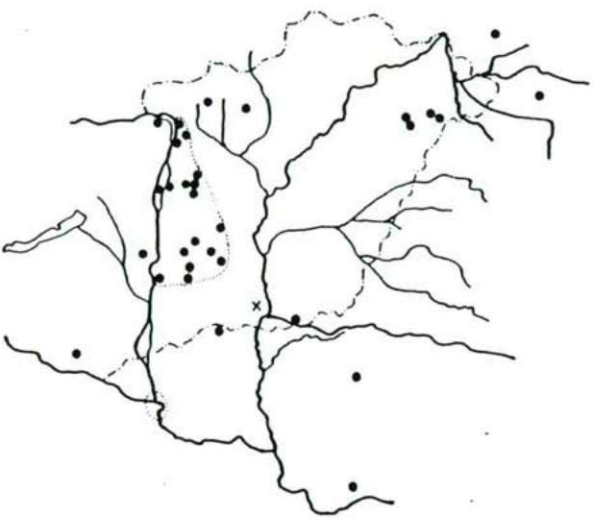

Fig. 2. Map of the distribution of *Dactylorhiza incarnata* (L. 1755) Soó 1960 at the Great Hungarian Plain. × marks the new habitat

Four plant species are rare and protected from the 40 species found at the above mentioned association. These are *Dactylorhiza incarnata, Iris sibirica, Koeleria javorkae, Orchis laxiflora* ssp. *palustris,* but latter is frequent at the Plain.

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Thesis of dissertation for candidate degree

MORPHOFUNCTIONAL STATUS OF LITHUANIAN CHILDREN
(age dynamics, factor pattern, secular trend from the material of investigation of Vilnius children)

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This candidate thesis deals with the problems of growth, development and secular trend of Lithuanian children and youth (from 2 till 18 years old) gives a complex analysis of morphological, functional traits, sexual development, physical activity and morbidity.

Data presented in this thesis based on a growth study carried out in Vilnius secondary schools and kinder gardens. The sample consists of 3792 children 2 to 18 yers age. Standard anthropometric and physiometric methods (MARTIN and SALLER, 1957) were used. Data were computed using linear and multiple analyses (statistical packages BMDP).

The results of this study allowed to make such conclusions:

1. Morphological status of Lithuanian children is follow:

— pubertal growth spurt of body height and the other longitudinal measurements occurs at the age between 13 and 16 years in boys and between 11 and 14 in girls. During the age period between 2 and 18 years body the height of boys increases from 89.2 to 179.6 cm, the girls one — from 87.8 to 165.6 cm.

— peak height velocity (PHV) of body mass is common at the age between 14 and 16 in boys (it coincides with the growth spurt of lean body mass — LBM) and between 12 and 13 y. in girls (coincides with PHV of LBM and body fat — BF). From 2 to 18 y. of age body mass increases from 13.1 to 70. 7 kg in boys and from 12.3 to 60.0 kg in girls. Absolute amount of LBM in boys during the period from 7 to 18 y. grows from 20.5 to 58.0 kg, in girls — from 19.4 to 43.

— sexual dimorphism of body composition is distinct since the middle of adolescence period: from 7 to 12 y. of age BF% in boys varies from 18.9 to 21%, in girls — from 19.4 to 20.9%. Later the rapid increment of LBM% occurs in boys (BF% decreases to 16.8% at the age 18), while in girls BF% grows until the age of 18 and achieves 28.7%.

— cluster analysis showed the different influence of various skinfolds on body fat through all 7—18 year-old period: BF% has the high correlation with all skinfolds in both sexes till the middle of adolescence, while later BF% in boys depends mostly on skinfolds of trunk and in girls — of limbs and abdomen.

— big body mass not always coincides with high BF% (especially in boys). Till the middle of pubertal period obesity occurs more often in tall children, while later it is more common in little children. It must be stressed, that small in height and

mass boys and girls have usually high LBM%. Therefore height and mass can't reflect the functional possibilities of organism.

— the main indices of proportions of the body are normal.

2. Functional characteristics can be summed up as follows:

— PHV of blood pressure, vital capacity, hand grip occurs as usually at the moment of the growth spurt of the main morphological indices. During the period between 7 and 18 y. blood pressure increases from 101.0/59.4 to 127.6/79.8 mmHg in boys and from 97.8/57.8 to 126.8/81.6 mmHg in girls. Vital capacity increases from 1391.0 to 4338.0 ml and from 1207.0 to 3096.0 ml, hand grip of right hand — from 10.3 to 46.5 kg and from 8.0 to 27.6 kg respectively.

— relative indices of strength and vital capacity change with the age differently than the absolute amounts and are connected with the body composition more closely. These indices in boys are higher than in girls and shows bigger functional possibilities of mail organism more expressively than absolute amounts.

— PHV of sexual maturation in boys occurs between 15 and 16 y. of age (Po = 14.80 y.), in girls — between 13 and 14 y. (Me = 13.37 y.). The earliest second sexual trait in boys is Pubes (12.5 y.), the latest one — Barba (>18 y.). First of all in girls hip become wider (9.0 y.), then occurs Pubes (11.12 y.), Mammae (11.49 y.) and Axillares (12.19 y.), hip widen not finished at the age of 18. Big in height and mass children have more higher degree of maturation than small ones. Sexual dimorphism is especially distinct in body composition and in functional characteristics.

3. Factor analysis of morphofunctional development including morphological indices, body composition, sexual maturation, physical activity and morbidity reveals that factor pattern depends on age and sex and shows the hierarchy of various indices:

— there are no sex differences in factor pattern of physical development until adolescence begins (at 12 y. of age in girls and 13 y. in boys). The first factor describes fatness (body fat, girths, some transverse indices). fhe second factor influences body size (the principal factor loadings fall on LBM, height, the other length measurements, biacromial and bicristal diameters).

— from the beginning of adolescence growth spurt sexual dimorphism of factor model is distinct: the first factor in girls describes body fat while in boys it influences body size.

— with some exceptions, separate and not connected factors influence morphological, functional characteristics and morbidity.

4. Secular trend in Lithuanian children between 1965 and 1985. has positive and negative affect on various morphofunctional indices:

— it was revealed the positive tendency of height with maximal values in the middle of adolescence, it is especially expressed in boys. As it concerns body mass and chest circumference, it should be mentioned only increment of absolute values in boys, while these indices in modern girls (compare to height) are less.

— gracilization and leptosomization of head and the upper part of the body in modern children is evident, while bicristal diameter during two past decades increased proportionally to body height. This process is more expressed in girls.

— the all functional characteristics have negative tendency since 1965. Therefore negative changes were found in growth and development of Lithuanian children during past two decades. The most striking factor is bad ecological situation in Lithuania. It must be stressed also such negative factors as decreasing physical activity, wrong nutrition, sharp socio-economic changes.

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CHRONICLE

Personalia

Dr. ERZSÉBET MIHALIK (Department of Botany), Dr. MARGIT SZABÓ Department of Plant Physiology) and Dr. KATALIN HALASY (Department of Zoology) have been appointed to Associate Professor by the Rector of the József Attila University.

Associate Prof. Dr. LAJOS ERDÉLYI has been appointed to the head of Department of Comparative Physiology.

Associate Prof. Dr. LAJOS ERDÉLYI has been appointed to the head and Associate Prof. Dr. ERZSÉBET MIHALIK to the secretary of the Group of Biological Department by the Rector of József Attila University.

Associate Prof. Dr. LÁSZLÓ GALLÉ has been appointed to deputy of dean of the Faculty of Natural Sciences of József Attila University.

Awards

Associate Prof. Dr. SÁNDOR GULYÁS (Department of Botany) was awarded the „Jávorka Sándor" award.

Associate Prof. Dr. ANTÓNIA MARCSIK (Department of Anthropology) was awarded the „For the Hungarian Nation Medallion".

Aspirant GYÖRGY PÁLFI (Department of Anthropology) was awarded the „Pro Sciencia Medallion" of Hungarian Academy of Sciences.

Scientific degree

The degree of candidate in biological science was obtained by:

Dr. MARGIT SZABÓ (Department of Plant Physiology) with her dissertation: Auxin habitation of tobacco callus cultures.

Foundation of Department

The Department of Ecology has been founded of the József Attila University by the Ministry of Education in 1991 and Associate Prof. Dr. LÁSZLÓ GALLÉ has been appointed to the head.

Foundation of Laboratory

The Cell Biological and Evolutionary Micropaleontological Laboratory of the Department of Botany of the József Attila University has been founded and Prof. Dr. MIKLÓS KEDVES has been appointed to the head. The journal of this laboratory is: Plant cell Biology and Development.

Retiring

Prof. Dr. LÁSZLÓ SZALAI (Department of Biophysics) and Associate Prof. Dr. ERZSÉBET K. SIROKMÁN (Department of Plant Physiology) retired.

Varia

The Department of Biophysics has belonged to the Group of the Departments of Physics since 1991.

Anthropological Scientific Session

An Anthropological Scientific Session was organized with 50 participants on the occassion of the 50th anniversary of the foundation of the Department of Anthropology, József Attila University in Szeged, from 1 to 3 October 1990. Besides Hungarian researchers 15 foreign researchers from 7 countries took part in the scientific session: G. HAUSER (Austria), R. STOEV (Bulgaria), U. CREUTZ, H. DANKER-HOPFE, H. SCHMIDT, R. SCHMIDT, V. SCHMIDT, K. SOMMER and H. WALTER (Germany), Ž. GAVRILOVIĆ and G. CZÉKUS (Yugoslavia), R. JANKAUSKAS (Lithuania), T. BIELICKI (Poland), B. KAUFMANN and GY. SKULTÉTY (Switzerland).

Lectures were given from growth and development, historical anthropology, paleopatology, constitution, sportanthropology and history of anthropology. Papers presented at the scientific session were published in 324 pages in „Papers of the Scientific Session in Szeged (Hungary) 1990" in August 1991.

On the occassion of the anniversary Prof. Dr. BÉLA CSÁKÁNY, the Rector of the József Attila University awarded the „Bartucz Lajos Medallion" to Prof. Dr. HUBERT WALTER (Bremen, Germany) and Prof. Dr. GYULA L. FARKAS (Szeged, Hungary).

Book review

MEADOWS, D. H. (1989): Harvesting One Hundredfold. Key Concepts and Case Studies in Environmental Education. — United Nations Environmental Programme, vii + 62 pp.

According to the author's intention, the book is devoted to conceptual introduction to environmental education. In my opinion, the main problem of the book is the mere conception itself. This book was written under the spell of the idea of the ‚sustainable development'. „Nature is not only beautiful to the eye but economically essential and irreplaceable...", can be found the sentence in the Foreward by M. K. TOLBA (Executive Director of the UNEP). It is true, but the motivation of nature conservation in the book is usually limited to emphasis at the fact that the biosphere is a kind of resource for the development and survival of the human race. This atti-

tude may be issued from that the book was written for those involved in every kind of education or education planning: that is for goverment leaders, teachers, ..., journalists, broadcasters, politicians, parents, all of whom are educators. None of them can be expected to be able to think about nature on an ethical — emotional basis; very often the protection of the biosphere means not more than the service of the incubator in which we are living (the metaphor was borrowed from SEBEŐK). It would be fruitful to understand that nature exists not for us, it exists for itself.

The main chapters have the following titles: What is Environmental Education and Why it is Important?, The Key Concepts of Environmental Education, Some Case Studies in Different Educational Contexts, Reading Lists, Appendix — Environmental Education in the United Nations: A Short History.

Chapter IV. (The Key Concepts of Environmental Education), which is very didactical, (and suggesting), consists of further parts: Levels of Being, Cycles, Complex Systems, Populations Growth and Carrying Capacity, Ecologically Sustainable Development, Socially Sustainable Development, Knowledge and Uncertainity, Sacredness. The economic development and care for the environment are compatible, interdependent and necessary, this also can be examplified, though not too well, by the following: „In Hungary soft coal is strip-mined from under prime agricultural fields. The topsoil is saved and returned to the site, drainage patterns are restored, soil fertility is carefully rebuilt. A few years after the mining is finished, the area is growing wheat again." It sounds nice, but any similar story very rarely occurs in Hungary; there are quite a number of examples for the ecologically not sustainable development.

In spite of this, due to the exemplary arrangement of the environmental information and the appropriate construction of the methodology, and, because the definitions of the environmental concepts are adequate to the aims, the book is highly recommended to use in practical fields of environmental education. Although the effectual arguments well emphasize the judgement of the environmental dependency of mankind, the environmental phylosophy reflects to a too anthropocentric ethos. — And this conception is more assailable than we would have belived it.

ISTVÁN BAGI
Department of Botany, József Attila University

Recensio

EIBEN, OTTÓ (Ed.) (1989): European publication in past, present and future. — Humanbiologia Budapestiensis 19., Budapest, 1989.; 224 pp., photos 19, figures 52, tables 79.

Volume 19 of Humanbiologia Budapestiensis includes selected essays of the VI. Congress of the European Anthropological Assosiation held in Budapest in 1988.

211 researchers of 21 European countries and the experts of Israel, Morocco, Nigeria, the USA and Venezuela took part on it.

This publication were published 2 years after the congress. It contains 42 papers of the 154 dissertations and posters shown on the three-day event.

The editor intends to issue the other publications in the Anthropological Communications (Journal of the Anthropological Section of Hungarian Biological Assosiation).

The papers are divided into three parts according to its topic.

In the first section there are 3 articles about the Hominid and other 13 dealing with Paleoanthropology. This part includes the Paleodemographic, Paleopathologic even Paleobiochemic essays.

The second section gathers 9 Humangenetic and Populationgenetic papers.

In the third section there are 17 dissertations about Body Composition, Growth and Developement and Secular Trend.

It is a very simple but nice publication which give us an insight into the divergent research-field of European anthropologists. Hopefully, other papers will be published in the Anthropological Communications.

ZSUZSA JUST

Department of Anthropology, József Attila University

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